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INJURIES TO THE EYE  
IN THEIR  
MEDICO-LEGAL ASPECT

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# INJURIES TO THE EYE

IN THEIR

## MEDICO-LEGAL ASPECT

BY

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WITH AN ADAPTATION OF THE MEDICO-LEGAL CHAPTER TO THE COURTS  
OF THE UNITED STATES OF AMERICA BY

CHARLES SINKLER, ESQ.

MEMBER OF THE PHILADELPHIA BAR



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## AUTHOR'S PREFACE.

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TRAUMATIC lesions of the eye and of the adnexa occur most frequently in industrial localities, where, for instance, metal factories, machine-shops, quarries, and mines predominate. Almost daily this type of cases comes to the physician; and, since many such injuries produce dimness of vision or give rise to complete blindness, and thereby, at times, become the cause of suits for damages, he is often called upon to state, in a medico-legal way, the cause, the nature, and the consequences of such traumatisms.

In certain cases the eye may be the seat of congenital anomalies, or it may exhibit more or less serious acquired lesions that have antedated the alleged accidental cause of the condition, and this, perhaps, unknown to the patient; so that, at times, it becomes necessary to differentiate whether a loss of vision, which may be partial or complete, is due to some definite injury or whether it is dependent upon some previous pathological change.

Laborers with a traumatic lesion of the eye often purposely neglect to follow a prescribed form of treatment; they may exaggerate the consequences of an accident; and frequently they may be induced to simulate blindness, in the hope of obtaining the largest redress that is possible under such circumstances.

As the answer to these different questions so frequently offers difficulties, and requires of the legal expert a profound knowledge of both the internal and the external diseases of the visual apparatus, it becomes obligatory that he be made fully aware of their medical significance, this

being further emphasized by the fact that it frequently becomes necessary, during the hearing of suits for this class of injuries, for the Court to call for the testimony of a specialist on diseases of the eye.

Even at a moment's notice the expert may be asked for his opinion by a corporation or by an individual regarding the gravity of an injured eye, or to give answer as to the visual function of persons whose interest induces them to assert that they cannot see, or that they do not see sufficiently well to pursue their occupations.

To guide the expert, and to make it easier to estimate accurately the damage caused by the injury to the individual, the author has attempted to present in this monograph a concise account of the traumatic lesions of the eye and of its adnexa, treating them especially from a prognostic stand-point. He has taken this opportunity to collect his personal observations,—the larger part of which has not been published,—as well as to compile the reports and published conclusions of his predecessors and collaborators.

As it is important that the medical expert, after having made a diagnosis, should not commit any legal error, a statement of the mode of procedure to be pursued in a medico-legal examination has been given in the final chapter of the book. The legal portion of this chapter has been written by Professor Jacquoy, of Lille, to whom the thanks of the author are due.

S. BAUDRY.

LILLE, FRANCE.

## AMERICAN EDITOR'S PREFACE.

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THIS work, which has achieved such a reputation in France as to demand a second edition, was sent to the editor by the author with the statement that, should the contribution be deemed sufficiently interesting and useful, a translation would be permitted. Careful reading of the original by the editor proved the work to be of so much value that he determined to accept the task and to present an English adaptation to the medical profession.

The at many times trying and difficult labor of obtaining the first and literal translation was assumed, and has been conscientiously accomplished, by Dr. Alfred J. Os-theimer, whose name appears upon the title-page. The modification of the legal side of the subject that had become necessary in order to accord this portion of the work with the American methods of dealing with such matters of jurisprudence has been accepted, and has been most judiciously done, by Mr. Charles Sinkler, to whom credit has also been given upon the title-page of the volume.

The revisional and editorial duties—consisting of a word-to-word comparison of the translation with the original text; the arrangement of the new matter into readable English, with the preservation of the author's style as much as possible; the preparation of the revised manuscript, the verification of the references, and the personal supervision of all of the press-work—have not been few, nor, as the editor hopes, in vain.

To Drs. Wilbur W. Bulette, of Pueblo, Colorado; Frederick C. Herrick, of Cleveland, Ohio; Mary E. Gillespie and Edward A. Shumway, of this city, many thanks are due for assistance given during the preparation of the English manuscript copy.

CHARLES A. OLIVER.

PHILADELPHIA, PA.



## CONTENTS.

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### PART FIRST.

#### TRAUMATIC LESIONS OF THE OCULAR ADNEXA.

##### CHAPTER I.

EYEBROWS, EYELIDS, AND CONJUNCTIVA.....	1
---	---

##### CHAPTER II.

ORBIT AND ITS CONTENTS.....	19
-----------------------------	----

---

### PART SECOND.

#### TRAUMATIC LESIONS OF THE EYEBALLS.

##### CHAPTER I.

CORNEA .....	33
--------------	----

##### CHAPTER II.

SCLERA .....	46
--------------	----

##### CHAPTER III.

IRIS .....	56
------------	----

##### CHAPTER IV.

CHOROID AND CILIARY BODY.....	61
-------------------------------	----

##### CHAPTER V.

RETINA .....	68
--------------	----

## CHAPTER VI.

CRYSTALLINE LENS .....	77
------------------------	----

## CHAPTER VII.

VITREOUS HUMOR .....	89
----------------------	----

## CHAPTER VIII.

TRAUMATIC LESIONS OF THE EYE AS A WHOLE .....	97
---	----

---

PART THIRD.

## CHAPTER I.

SIMULATED OR EXAGGERATED AFFECTIONS OF THE EYE .....	110
--	-----

---

PART FOURTH.

MEDICO-LEGAL EXPERT TESTIMONY .....	133
-------------------------------------	-----

BIBLIOGRAPHY .....	142
--------------------	-----

INDEX .....	151
-------------	-----

PART FIRST.

TRAUMATIC LESIONS OF THE OCULAR  
ADNEXA.

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CHAPTER I.

EYEBROWS, EYELIDS, AND CONJUNCTIVA.

(A) EYEBROWS.

THE superciliary region, supported by the projection of the superciliary arch of the frontal bone, is exposed to such injuries as wounds, burns, and contusions. These injuries, when superficial and limited to the soft parts, are not, as a rule, serious, but may be followed by disastrous consequences, and even by fatal results should they affect or extend to the underlying bones. Simple contusion of the eyebrow does not usually give rise to more than an ecchymotic swelling, resolution of which is quickly obtained by compression and massage. If, however, a violent contusion disturbs the soft parts, or a compound fracture be produced, suppuration, followed by periostitis, necrosis, fistulas, and other complications, may take place.

Happily, by the aid of asepsis and antiseptics, wounds caused by cutting implements or stabbing instruments heal in a few days' time, even if the injury be extensive and the periosteum be penetrated and exfoliated.

In the following case primary union was obtained and the patient resumed work on the twelfth day after the accident, notwithstanding that almost four centimeters of the frontal bone were denuded.

CASE I (personal and previously unpublished).—Extensive wound of the right superciliary region caused by the bursting of a siphon of Seltzer water. Denudation of the frontal bone. Re-union by first intention.

A. D., aged 34 years, employed in the manufacture of Seltzer water, began work on the twenty-fourth day of June, 1889, without any protecting metal mask. By the bursting of a siphon he was struck in the right superciliary region with a piece of glass, a wound four centimeters in length which passed through the entire thickness of the brow being produced. The periosteum was smoothly cut and the frontal bone was denuded almost throughout its entire length. After arresting the hemorrhage, and being assured that there were no pieces of glass in the wound, three sutures were put in place and a compress-bandage was applied. Union by first intention was obtained, and the patient resumed his occupation on the twelfth day.

In a wound that is limited to the integument of the brow the edges have no tendency to separate, because of the close attachment of the skin to the deeper layers in this region. In consequence, there is no necessity for suturing, small bands of adhesive plaster being sufficient to obtain exact coaptation.

Reservation as to prognosis must be made, however, if the wound cannot be made aseptic by the removal of the foreign bodies. Persistent neuralgia, motor and visual disturbances, and trophic lesions must, at times, be expected, if the supraorbital nerve or any of its branches is wounded or is imprisoned in an adherent cicatrix.

In the case of contused wounds it is well to remember that it is sometimes difficult to determine the kind of instrument by which they have been produced, because

of the fact that some of these solutions of continuity of tissue so closely resemble wounds that are caused by cutting instruments: for example, the sharp edge of the superciliary arch may cut the soft parts lying between the bone and the contusing body from within outward. Such injuries may also be produced by falls upon the ground or upon ice.

The diagnosis of this class of injuries is, from a medico-legal stand-point, of the greatest importance, and the prognosis is always unfavorable, not only on account of the depth of the wound and the denudation of the bone, but also by reason of the disturbance of the surrounding tissues, which is proportionate to the violence of the traumatism.

With antiseptic treatment the majority of contused wounds heal in a few weeks' time, but when infection has been produced by the penetration of a septic foreign body, erysipelas may appear, or suppurative inflammation involving the loose cellular tissue of the upper lid, and exceptionally that of the orbital cavity may take place.

Suppuration of the orbital connective tissue is in all cases a serious complication of contusions of the superciliary region, while phlegmonous inflammation of the upper lid may sometimes lead to a more or less extensive destruction of tissue, with disfiguring cicatrization.

If bone-tissue is involved, osteitis, necrosis, and fistulas may result, or even a fatal issue may ensue, particularly if the walls of the frontal sinuses are fractured. The prognosis is less serious when the lesion is limited to the external wall of the orbit, as shown by the following observation of Tillaux<sup>1</sup>:—

A girl, aged 20 years, with well-developed frontal protuberances, fell while carrying a sandstone pitcher, which broke and

cut a gaping wound in the right brow that was sufficiently large easily to admit a finger. The base of the fractured anterior wall of the frontal sinus was forced in, and a fragment of the jug was imprisoned in the cavity. The fracture was filled with blood and there was a pulsation which was synchronous with the radial pulse, leading the observer to the belief that the brain-substance was exposed. A rapid recovery followed the extraction of the foreign body.

Hippocrates observed that injuries of the brow often caused blindness, and surgeons generally endeavor to associate partial or total loss of vision, which may be transient or permanent, with contused wounds of the edge of the superciliary region of the orbit.

Published observations show that sometimes complete blindness has been immediately produced. In other instances the blindness has been gradual in its onset. The author has seen cases of less pronounced visual disturbances which have grown better and in which the symptoms have finally disappeared.

Before the discovery of the ophthalmoscope, the theory given was that traumatic irritation usually started from the injured branches and in various ways reached the optic nerve, producing a sympathetic or a reflex amaurosis. The experimental and therapeutic sectioning of the supra-orbital nerve, the existence of amblyopia or amaurosis produced by wounds in the orbit,—other than those which are in direct communication with the frontal nerve,—should all long ago have discredited this idea, notwithstanding the success of Beer in performing supra-orbital neurotomy.<sup>2</sup>

Since the use of the ophthalmoscope and the greater opportunity of making autopsies, anatomical lesions which have shown more precise connection with the various forms of visual disturbance have been discovered. For

example, a retrobulbar neuritis following either a direct or an indirect fracture of the optic canal (with a crushing of the optic nerve by a splinter of bone, for instance); or a primary compression of the nerve by an extracapsular or an intracapsular effusion (von Hölder) may take place from the same cause; or a secondary form of compression from callosities or periostitis may be the result; again, intraocular lesions, such as hemorrhages, retinal detachment, and rupture of the choroid may occur.

Moreover, effusions into the vitreous humor, neuritis produced by erysipelas of a wound (H. D. Noyes), or atrophy from intracranial lesions may appear. Finally, in some cases in which visual defects are temporary and are of less importance, it may be admitted, in the absence of absolute anatomical proof, that there has been a disturbance of the retina or of the nervous centers.

Callan<sup>3</sup> has reported nine cases of traumatism ending in monocular blindness, produced by fracture of the orbital bones at the optic foramen.

Raymond<sup>4</sup> has seen a case of injury to the orbital margin producing a tear of the choroid, which had six times the diameter of the optic-nerve head. In this instance vision was abolished for a long period of time, and the eye was the seat of an intense ciliary neuralgia.

Considering the reports of all such cases, there is but little to support the theory of a reflex amaurosis that is solely connected with injury to one of the branches of the frontal nerve.

In 1877 Badal reported a case in which he extracted a piece of wood that three weeks previously had penetrated deeply beneath the skin above the brow, and had lodged across the supraorbital nerve. The irritation of the foreign body produced a neuroretinitis, with a conse-



quent diminution of vision to one-half of normal. Rapid recovery followed the operation.

If, however, it is decided to consider an exceptional form of reflex amaurosis following lesions of the fifth pair as dependent in great measure upon traumatic hysteria, it is not singular that continuous irritation of the nerve-branches that are imprisoned in a cicatrix which is adhering to the bone, and is dragged by cicatricial retraction, should reappear in the form of hyperemia, photophobia, paresis of the power of accommodation, and blepharospasm. De Wecker, indeed, seems to admit that much prolonged irritation may so modify the intraocular secretions as to produce simple chronic glaucoma.<sup>5</sup>

The liberation of the adherent cicatrix and of the nerve that is contained in the cicatricial tissue is usually successful in dissipating the neuralgia, the blepharospasm, and the visual disturbances. A number of cases that are analogous to the following have been published by different surgeons.

CASE II (personal and unpublished).—Contused wound of the left brow. Cicatrix adherent to the frontal bone. Neuralgia and visual disturbances. Liberation of the cicatrix. Recovery.

G. S., 21 years old, an apprenticed roof-builder, on the fourteenth of March, 1890, fell from the first story of a building. He was picked up unconscious, and remained in this condition for several hours' time. The attending physician found a simple fracture of the left clavicle, and a contused wound of the brow of the same side. According to the patient's account, the wound suppurated for twenty-five days, and the left eye was closed for about fifteen days by the inflamed and swelled upper eyelid. At this time the patient said that there was no change in his sight. He resumed work a month after the accident.

On the eleventh of July he consulted the author on account of a disturbance of vision in the left eye, which had lasted for about six weeks' time. He complained especially of photophobia

and of rapid fatigue of vision. Persistent pain, with exacerbations in the left frontal region, was a prominent symptom. The pain seemed to originate in the wound in the brow, and to radiate toward the left side of the head. The left eye frequently became inflamed. At this visit the patient asked for a certificate in order to be able to claim damages from an insurance company.

On a plane with, and a little above, the left supraorbital notch there was a cicatrix, which was adherent to the frontal bone. Slight pressure upon this region provoked a localized increase of pain. There was a slight contraction of the muscles that were supplied by the facial nerve, this being more particularly pronounced in the region of the left orbicularis. The external ocular membranes seemed normal, the left conjunctiva being but slightly more injected than that of the right eye. The left pupil was contracted. The refracting media were transparent, and there were no appreciable lesions of the eyegrounds. With the aid of a convex spherical lens of one and a half diopeters' strength, the visual acuity on each side became normal. The visual fields were unimpaired.

Considering that the symptoms were due to an incarceration of the nerve-filaments in the cicatrix, the author loosened all of the adhesions which bound the cicatrix to the underlying bone by means of a tenotome, resulting in the cure of the case.<sup>6</sup>

It has already been noted that motor and trophic disturbances result from injuries to the branches of the fifth cranial nerve. These cases, however, are rare. Tardif reports an example from de Wecker's clinic, in which persistent contracture and neuralgia, which were dependent on the presence of a small piece of wood in a wound of the eyebrow, were permanently relieved by the extraction of the foreign body.

In nervous patients wounds of the supraorbital nerve may produce facial paralysis, trismus, and, exceptionally, tetanus, epileptic attacks, and general convulsions.<sup>7</sup> Ultimately such traumatism may lead to trophic disturbances of the face, such as partial hemiatrophy (see Case IV in

Tardif's thesis), and to alterations in the nutrition of the eye. Brière has published an example of trophic keratitis that was due to a contused wound of the outer third of the eyebrow, and in which there was no direct involvement of the eye.<sup>8</sup> The condition known as enophthalmos has been reported.<sup>9</sup> In some cases this symptom was accompanied with a marked loss of visual acuity.

Wounds caused by projectiles are to be placed in the same category as contused ones. In such cases the frontal sinuses may be opened and both walls either splintered or simply fractured. Injuries that are limited to the outer wall are rarely serious, the emphysema soon disappearing, though they may produce a fistula or act as a cause of delay in recovery. On the other hand, if the cranial wall is involved, the prognosis is grave on account of the possible infection of the meninges, particularly if the projectile remains in the cranial cavity or if it becomes imbedded in the posterior wall of the sinus.

Burns of the eyebrow require, for their healing, a period of time that is proportionate to the severity of the injury. They always leave a more or less noticeable cicatricial deformity.

From a medico-legal point of view, the preceding considerations may be summed up as follows: Violent contusions and contused wounds of the eyebrow are often followed by a temporary or a permanent loss of vision, which may be immediate or secondary. This diminution of visual acuity may depend upon definite anatomical lesions of the orbital walls, of the eyeball, of the nervous centers, etc.; but there are, however, a certain number of cases in which the ophthalmoscope fails to reveal any alteration of the fundus for some time following the traumatism. Before forming an opinion, the medical expert should, therefore,

insist upon having the patient under observation for several months' time: until all possible retrobulbar lesions have had sufficient time to act upon the nutrition of the optic nerve.

Reflex amblyopia without material evidence following blows upon the forehead, or insignificant periorbital contused wounds, may form the basis for damage-suits, and should be admitted only with the greatest reserve. The expert must always suspect traumatic hysteria, the diagnosis often being of the utmost importance. Intermittent unilateral amblyopia—characterized by a variability of the ocular symptoms, absence of ophthalmoscopic changes, and a concentric contraction of the visual field for white and for colors—in an hereditary neuropath is quite pathognomonic of traumatic hysteria.

Moreover, there are instances in which preservation of the iris-reflex with other signs suggests an attempt at simulation; these will be considered in a special chapter.

Injury of the supraorbital nerve may produce cranio-facial neuralgia, muscular twitchings in the facial region, trophic changes in the eye, and, finally, give rise to visual disturbances that are characterized particularly by photophobia and accommodative asthenopia. These symptoms are generally curable, and give but slight inconvenience to the patient.

The majority of wounds caused by stabbing, cutting, or contusing instruments, and uncomplicated burns that are limited to the soft parts of the brow, heal quite rapidly, entailing but a brief absence from work. Fractures of the supraorbital ridge and deep wounds of the frontal sinus are much more serious, being sometimes followed by meningitis or meningo-encephalitis.

Finally it must be again mentioned that contused

wounds of the brow produced from within outward by the action of blunt implements, or by falls, may present the appearance of injuries that have been caused by cutting instruments. From a medico-legal stand-point, it is important for the expert to recognize this peculiarity, because, in certain cases, the accused may be prosecuted for armed assault, when in reality the wound that has been inflicted has been the result of a blow by a fist.

(B) EYELIDS.<sup>10</sup>

Wounds of the eyelids are quite common, their gravity being greatly increased when the lids are perforated and when the eyeball or the orbit is involved. They are commonly due to blows made by the naked or the armed fist, to falls upon resisting surfaces, etc. Burns may result from explosions of gas or of powder, from the action of boiling fluids, or of incandescent bodies, such as iron and phosphorus, and from the action of acids or caustic alkalis, whether projected accidentally—for example, during their manufacture—or purposely thrown with criminal intent (vitriol).<sup>11</sup>

Contusions more frequently affect the edges of the orbit and the nose than the eyelids. By reason of the great vascularity and the laxity of the palpebral areolar tissue they are generally accompanied by free extravasations of blood, either in the form of diffused ecchymoses or of hematoma. In their differential diagnosis it is necessary to distinguish those forms of infiltration which appear immediately after traumatism from the later-appearing ecchymoses that are symptomatic of fracture of the anterior wall of the skull or are expressive of rupture of the deep orbital vessels. The former conditions are more unsightly than

important, but in the latter the patient should be placed under a prolonged period of observation before any definite prognosis can be given.

Wounds made by pointed instruments heal rapidly and often without scars. It must not be forgotten, however, that they may involve the eyeball or injure the contents of the orbit, especially the tissues of the optic nerve. Medical literature contains many instances in which sharp objects—such as fragments of wood, steel, and lead—have penetrated into the orbital tissues and have remained imbedded, leaving barely-perceptible scars.

A horizontal wound, produced by an aseptic cutting instrument, even when extensive, usually heals without deformity, unless the suspensory ligament of the upper eyelid be cut. In such cases, if the detached end of the levator of the lid is not successfully sutured to the tarsus, the resulting ptosis becomes permanent. Vertical or very oblique incisions which include the entire thickness of the eyelid, and its free margin, lead, when union by first intention is delayed, to coloboma, ectropion, entropion, trichiasis, etc. Division of the internal palpebral ligament or of the canaliculi may disturb the function of the lacrymal apparatus. If the ocular conjunctiva is cut, marked limitation of the movement of globe and lids may ultimately result from a consequent symblepharon. The tears that are sometimes produced by blunt implements are rarely of more gravity than those that have resulted from cutting instruments, and, unless the parts are too much crushed, primary union may be obtained by careful suturing. The following case proves this:—

CASE III (personal and unpublished).—Extensive laceration of the lower eyelid by a blow from a fist. Suture. Healing by first intention.

In May, 1880, N. J., a horse-trainer, during an altercation with one of his comrades, received a violent blow on the right eye. Compresses of dilute tincture of arnica were applied. The author saw the patient forty-eight hours later. In addition to an ecchymotic swelling of the lids and the root of the nose and the cheek, there was a wound beginning at the internal canthus, which involved the lower eyelid, at a distance of three centimeters from its free border. After a careful cleansing of the injured region, four sutures were applied. The stitches were removed on the third day, primary union having been secured throughout. When seen later the eyelid was found to be in good position, and although the lacrymal duct was obstructed the patient did not complain of any epiphora.

Infinitely more dangerous are extensive contused wounds with ragged, uneven edges. This is so, as such wounds rarely unite by first intention, and are too often complicated by suppuration, erysipelas, and gangrene. In addition, cicatricial deformities—such as ectropion, entropion, and trichiasis—may all appear as consequences. Although some of these subsequent conditions are in part curable by operative procedure, yet the nature of the injury is none the less important. The possibility of extension of phlegmon or of erysipelas to the orbital cavity, the production of a thrombophlebitis (an exceedingly serious lesion), and the occasional occurrence of amblyopia and amaurosis must all be considered. Schwendt<sup>12</sup> reports seven cases of amblyopia and two of amaurosis as appearing in forty-four cases of erysipelatous phlegmon of the orbit. These types of traumatism are often aggravated by the presence of a foreign body—such as a fragment of lead, wood, and metal—which, after closure of the wound, may become encysted in the loose cellular tissues of the eyelid, or become the starting-point for inflammatory conditions whose repetition and persistence have a special semeiological significance.



Burns of the so-called first and of the second degrees give rise to scarcely any deformity. Grains of powder that are not immediately removed leave indelible black stains of carbon. In the acute condition the eyelids may be considerably swelled. Deep burns may destroy the skin, the subcutaneous areolar tissue, the fibers of the orbicularis muscle, etc. In such cases the resultant eschars are followed by cicatricial contraction, displacement of the lid-borders, adhesion of the free edges of the eyelids, and even attachment of the ocular and palpebral conjunctivæ. These conditions are more serious when the ocular conjunctiva and the eyeball itself are simultaneously involved. There are rare cases in which the eyelids have been completely destroyed.

In brief, superficial and isolated burns and simple wounds caused by pointed or cutting instruments heal rapidly without serious results. On the contrary, deep burns, severe contused wounds, especially those that are produced by fire-arms, are dangerous. They incapacitate the patient for work for a period of some weeks, and their complications at times are so severe as to threaten life. They always entail deformities that are more or less incurable and are detrimental to vision.

As a rule, the color of the eschar is an indication of the nature of the caustic agent, that of nitric and hydrochloric acids, for example, being yellow, while that of caustic potash and sulphuric acid is blackish in tint.

#### (C) CONJUNCTIVA.

Wounds, foreign bodies, and burns of the cornea and conjunctiva are of daily occurrence, especially in industrial centers. Frequently the lids are wounded, and occasionally

a muscle is injured at the same time. Ordinarily the physician sees but a small percentage of cases of this type. Slight burns of the conjunctivæ, such as those that are caused by minute incandescent particles of iron, chipped off by a hammer, produce only slight injection; these heal after a few days' rest with the application of cold compresses. Frequently a great number of small foreign bodies are expelled almost as soon as they strike the membrane, this being accomplished by the natural movements of the eyelids and by the efforts of the patient. At other times, fellow-workmen succeed in freeing the eye from foreign particles that may be lying free in the conjunctival sac.

Blunt bodies, such as chippings from iron castings, flying, without much force, against the lids, or driven directly against the conjunctival membrane, often contuse the conjunctiva without producing deeper injuries. Generally an ecchymosis, which immediately elevates the conjunctiva, appears, and, in accordance with its degree, gives rise either to a simple suffusion or to a thrombus which may extend beneath the bulbar mucous membrane. At times, a ring of chemosis situated around the cornea may be formed. If the injury is slight, a resorption of a subconjunctival ecchymosis generally takes place in one or two weeks' time. Extensive extravasations may impair the nutrition of the cornea, by compression, and exceptionally they may produce a rupture of the mucous membrane, thus leading to the formation of localized abscesses. Here, too, care should be taken not to confound such extravasations with those that are due to fracture of the orbit or of the base of the skull. As a rule, the latter do not appear until several days after the accident, involving first the inferior *cul-de-sac*, and then spreading beneath the bulbar conjunctiva. A subconjunctival ecchy-

mosis may rarely conceal a wound of the subjacent sclera; but, in such cases, other objective and functional symptoms will show that the conjunctiva is not alone involved.

Wounds of the conjunctiva caused by sharp objects have the appearance of surgical incisions, and heal in several days' time, particularly if the offending agent is aseptic and the wound is perpendicular or very oblique. Should there be the formation of a flap, even if the wound is transverse, the gravity of the prognosis is not increased, unless the pedicle is very narrow. A large denudation of the sclera by death of a broad conjunctival flap is, nevertheless, an unfavorable complication, for, beside the slowness in healing, the loss of substance, unless great care be taken, gives rise to a considerable shortening of the conjunctival membrane; moreover, when there is a loss of substance at a corresponding point of the palpebral conjunctiva the two parts unite, and produce a complication, the gravity of which will be shown in the section on burns of the conjunctiva. Similar consequences follow contused wounds, which are, however, generally accompanied by serious lesions of the subjacent tissues.

The prognosis of injuries of the conjunctiva due to foreign bodies is very favorable.<sup>13</sup> The inflammation, the blepharospasm, and the pain, that indicate their presence, all disappear as if by magic after the removal of the foreign material. Relatively large foreign bodies may remain for months and even years hidden in the hypertrophied folds of the conjunctival *cul-de-sac* without producing any other symptoms than those of slight discomfort, swelling of the eyelid, and chronic irritation, which is accompanied by a muco-purulent discharge.

Fraenkel<sup>14</sup> cites a case in which a piece of wood, fifteen millimeters in length and fifteen millimeters broad, had

lain in a conjunctival *cul-de-sac* for twelve years. Similarly, grains of lead or of powder and small pieces of glass may become encysted in the bulbar conjunctiva, and be very easily tolerated. In another publication<sup>15</sup> the author has recorded the discovery of a piece of glass, three millimeters long, in the center of a fungous vegetation of the semilunar fold. The patient remembered that he had been wounded eight years before by the breaking of a bottle which he was corking. He had never suffered from the excrescence, coming to the author to have it removed merely because it was increasing in size and bled on the slightest touch.

Burns of the conjunctiva<sup>16</sup> are usually complicated by similar conditions of the lid, of the sclera, and of the cornea; and, in consequence, they are generally serious in character. As a rule, they are the result of the action of steam, alcohol-flames, gas, etc. Frequently they are produced by chemical agents, acids, alkalies, heated and incandescent solids such as metallic particles, charcoal, fused wax, pitch, boiling oil, heated water, and phosphorus. On account of their diffusibility, chemical agents spread more rapidly and extensively to the surrounding tissues; they do not, however, burn so deeply as substances in a state of ignition.

Acids (hydrochloric, nitric, and sulphuric) are frequently thrown into the eye either by accident or intent. They often produce injuries the depth and the gravity of which are proportionate to the concentration of the material and to the duration of the primary burning. Perforation of the globe may result from destruction of the subjacent sclera and of the cornea, and the eye may be lost. Burns by mortar are common, but if the foreign substance is not very caustic, and if it is removed at once, any resultant conjunctival inflammation heals rapidly and

the patient will be able to resume work in a few days' time. The results, however, are different when deep burns are produced by quick-lime or by acids. In addition to a possible perforation of the eyeball and the evacuation of its contents, more or less extensive adhesions between the lids and the eyeball (symblepharon, ankyloblepharon, etc.) may be formed: conditions which are often incurable and frequently disturb the function of the organ. It is important to determine whether the conjunctival *cul-de-sac* has escaped injury, for, in many instances if a symblepharon is incomplete, it may be readily removed by judicious treatment, and the earning capacity of the patient will not be appreciably diminished, as the following case illustrates:—

CASE IV (personal and unpublished).—Burn of the conjunctiva by a boiling solution of potash. Partial symblepharon, with traumatic pterygium.

On December 27, 189-, the author made an examination of X, a 20-year-old man who was injured on the 30th of June, of the same year, by a boiling potash solution, to determine (1) the existence of a permanent lesion of the right eye, (2) its nature, and (3) its effect upon the earning capacity of the patient. X resumed his work eleven days after the accident, and claimed heavy damages for the injury. Examination revealed the presence of a loose band of adhesion situated between a point of the lower lid and the eyeball on the right side, and of the existence of a fibrous extension in the form of a pterygium, which occupied the infero-external part of the bulbar conjunctiva, the latter encroaching, for a distance of two millimeters, upon the corresponding part of the cornea. Examination with oblique illumination and with the ophthalmoscope failed to show any other lesion of the cornea, of the media, or of the deeper portions of the eye. Central and peripheral visual acuities were normal. There was neither strabismus nor limitation of the movements of the globe in any direction. The wage value of the patient was consequently but little decreased by the traumatism, which did not impair any of the essential functions of the organ.

However, as cicatricial tissue in time undergoes special changes, it is always necessary to wait several months before deciding definitely upon the amount of ultimate contraction of such bands, and of the consequent limitation of the movements of the eye.

Burns by alcohol-flames, which the author has seen in men while engaged in welding metals, have been superficial, and do not require special mention. Those that are produced by steam from the bursting of steam-pipes, boilers, etc., are often complicated by more severe lesions, which are due to flying pieces of metal or glass. The violence of the action of fused or incandescent bodies depends upon their temperature. Burns by iron dross, wrought iron, or fused brass and steel, the temperatures of which are always above 1000° C., are common among blacksmiths, rollers, and smelters. They are ordinarily quite deep, and lead either to the loss of the eye or to extensive cicatrization.

Drops of metals that fuse at low temperatures—such as lead, zinc, tin, and antimony—may enter the conjunctival sac without producing serious lesions. An ingenious explanation has been given for this fact by Ferrier.<sup>17</sup> In accordance with a phenomenon, known in physics under the name of calefaction, the tissues are separated from the metal by a cushion of gas that is produced by a sudden evaporation of the fluids on the surface of the eye, and are no longer exposed to the heat of the fused metal. In addition to others, the author has published several cases of such superficial burns.<sup>18</sup>

## CHAPTER II.

### ORBIT AND ITS CONTENTS.<sup>19</sup>

THE gravity of traumatisms of the orbit is most variable on account of the importance and the multiplicity of the tissues which compose this region and also by reason of the proximity of the cranium. The maximum degree of severity is reached when the eyeball at the same time is injured, or when the wounding agent penetrates the cranial cavity. In practice, traumatisms of the orbit are frequently complex in character; that is, the lesions of the soft parts are complicated by fracture of the orbital wall or by the presence of a foreign body; but for clearness of demonstration it is customary to consider successively traumatic lesions: *(a) of the orbital walls (b) of the soft parts of the orbit.*

#### (A) ORBITAL WALLS.

In the study of the traumatic lesions of the eyebrow and lids, which has just been made, it was seen that blunt instruments striking the orbital edge produce, according to the violence of the traumatism, subcutaneous, subaponeurotic, or, more rarely, subperiosteal hemorrhages. It will also be noticed that a linear division of the soft parts may be made from within outward, and that it may be accompanied by a denudation of the bone which is often followed by prolonged suppuration, orbital phlegmon, or severe cranio-facial erysipelas. In addition, there may be



a radiating fracture in the corresponding wall, and finally various functional disturbances—such as neuralgia, anesthesia, and amblyopia—may appear.

In general, moderate contusion of the base of the orbit gives rise only to bloody suffusion, which distends the lids, spreads across the face, and occasionally reaches the other side. Complete absorption of the blood is the rule, but in some instances the effusion may persist and produce slight periosteal indurations or neuralgic pains.

Prognosis is unfavorable when the traumatism has stripped the periosteum and has produced a fracture of the orbital walls. This point has already been sufficiently dwelt upon. It is necessary, from both a diagnostic and a prognostic point of view, to remark here, however, that the appearance of an orbital hematoma, after contusion of the orbital edge, implies the existence of an injury to the cavity itself, as the tarso-orbital fascia is closely attached to the bone, and prevents the spreading backward of any superficial extravasation.

A loss of substance that is limited to the edge of the orbit is very rare, and, as a rule, can only occur when the wounding agent merely grazes the bone. The diagnosis must be made on symptoms that vary with the position of the traumatism; slight emphysema, in case of the opening of a sinus; anesthesia of one-half of the upper lip, and of the corresponding ala of the nose, if the supraorbital nerve has been injured by the separation of the zygomatic-maxillary suture or by fracture of the floor of the orbit<sup>20</sup>; obstruction of the upper part of the nasal duct by a fragment of bone<sup>21</sup>; and, finally, cicatricial ectropion (Mackenzie).

As a rule, one or more of the walls of the orbit are involved in an injury to the orbital edge. Extension to the thin bone forming the vault of the cavity is the most impor-

tant, because of the immediate proximity of the meninges and of the possible development of a fatal meningo-encephalitis. However, Berlin's statistics show that, out of 19 cases of simultaneous fractures of the edge of the orbit and of the vault, there were 16 recoveries; while 52 cases of fractures limited to the superior wall were followed by 41 deaths. In the first series of cases the violence of the traumatism was probably neutralized, in part, by the prominence and the resistance of the edge of the orbit.

As a rule, all interest in injuries to the orbital wall centers in fractures. Those caused indirectly take place either by *contrecoup* or more frequently as the result of an extension of fractures of the superior maxillary or malar bones, this being especially true for the middle or the anterior fossa of the skull, and in falls on the head or in crushing injuries of the face and temples. In 96 cases of fractures of the base of the skull, due to shot wounds or to falls, Hölder found fractures of the vault of the orbit in 73 instances; involvement of the superior or internal wall of the optic canal 53 times; subvaginal extravasation of blood in 42 cases; complete unilateral blindness in 27 cases; and incomplete amaurosis in 4.

The effect upon the vision will be the more serious if the optic nerve and its sheath are violently torn and compressed,—aside from the gravity of the cerebral lesions, which depend upon fracture of the skull. Absolute blindness, discovered immediately after the return of the patient to consciousness, with or without ophthalmoscopic appearances of papillary stasis or of hemorrhages in the retina and vitreous, serves for a bad prognosis; while the preservation of a part of the peripheral visual field gives hope of the return of a relative amount of visual acuity.

Finally, paralysis in one or more of the muscles indi-

cates the probable involvement of the sphenoidal fissure, and it will be seen later that, aside from traumatism of the cranium, those of the orbital region (contusions, foreign bodies, etc.) have an important bearing on the etiology of paralysis of the eye-muscles.<sup>22</sup> Casper has published a case of paresis of the internal rectus and the superior oblique muscles that was due to the penetration of a cutting instrument into the upper, internal part of the orbit. Grevin has seen an instance of paralysis of the superior oblique muscle the result of a contusion of the orbital edge.

Direct fractures are quite frequent, and are, as a rule, produced by projectiles and pointed objects,—such as swords, naked foils, forks, and files. They are also frequently caused by thrusts from the horns of cows, the ends of canes, and umbrella-sticks. The wounding body may penetrate into a sinus or the cerebral cavity or into the nasal fossæ. It may also pass into the opposite orbit and produce important and complex organic or functional disorders. The external orbital wall is particularly liable to fracture by projectiles from fire-arms. The mass may either simply shatter the wall and displace the eye forward and inward or it may emerge from the opposite temple, after having severed the optic nerve or destroyed the eyeball. A pointed instrument, such as a fragment of wood (de Wecker<sup>23</sup>) may easily perforate the internal wall, and enter either the nasal fossæ or the neighboring sinuses, producing epistaxis and emphysema of the orbit and lids. If the globe has not been involved, and if the wound is not infected, the patient is, as a rule, merely incapacitated for work for a brief period of time.

Much more serious is the result of a direct fracture of the superior wall of the orbit. Such a traumatism involves

the optic canal in more than one-half of the cases; and, according to Berlin's figures, shows a mortality of 80 per cent. Lesions of the internal carotid artery, the cavernous sinus, and the anterior cerebral artery, as a rule, produce sudden death. In some other cases the patient succumbs later to an infectious meningo-encephalitis and suppurative thrombophlebitis, or, if the carotid artery has been wounded in the cavernous sinus, he may soon evidence an arterio-venous aneurism.

The character of treatment that is employed at the present day allows many of these severe forms of traumatism to terminate happily, even when they have been at first complicated by alarming cerebral symptoms; in fact, some such cases have been mentioned in medical literature long before the era of asepsis and antisepsis.

Although the diagnosis of such fractures is often obscure, exploration with a probe should, as a rule, be avoided, for the condition of the patient may be fatally aggravated either by infection or by the displacing of a foreign material—for example, a bony splinter—into the cranial cavity.

#### (B) INJURIES TO THE SOFT PARTS OF THE ORBIT.

It is well known that as a result of the shape and the free mobility of the eyeball a wounding object may pass around its fibrous sheath and produce an injury of the surrounding soft parts of the orbit only. The importance of such a form of traumatism depends, above all, on the cleanliness of the penetrating body, its degree of bluntness, and whether it has a pointed or a cutting edge. If the offending instrument has not been freed from septic material while passing through the skin, the conjunctiva, and the orbital septum, it may act as the cause of a cellulitis and its dangers, not only for the preservation of vision (amaurosis by

atrophy, etc.), but also for the life of the patient (for example, by thrombosis of the ophthalmic veins and of the sinuses). Section of the ophthalmic vessels, rupture of the ocular muscles, injuries to the sensory and the motor nerves, and the presence of foreign bodies are among the most interesting lesions of the soft parts of the orbit.

Laceration of the arteries, veins, and capillaries is rapidly followed by an extravasation of blood, which infiltrates the orbital cavity, passing into Tenon's space and the subconjunctival cellular tissues, producing an exophthalmos, the degree of which varies with the extent of the hemorrhage. Later, a palpebral ecchymosis appears. As a rule, several weeks suffice for the absorption of the blood, but excessive compression from the effusion has, at times, led to a phthisis bulbi (Berlin). Gepner reports a case of neuroretinitis, with atrophy of the optic nerve, as the result of an intraorbital hemorrhage.<sup>24</sup>

Rupture of an ocular muscle, detachment of its tendon from its insertion into the sclera, and injury to a motor nerve are all relatively rare types of injury. The result, in each instance, will be a traumatic paralysis, with strabismus and diplopia, which, aside from the vertigo and the disturbances in gait that it entails, is always a serious obstacle to work, and considerably reduces the earning capacity of the individual. It is true that this double vision can, as a rule, be fairly well corrected by an operation or by the use of appropriate prisms. This correction, however, is often far from being satisfactory, and, as a rule, the patient is compelled to wear a ground-glass before the affected eye, unless he gradually learns to disregard one of the sensory images. At times, consequently, the effect of the injury is very severe, becoming almost equivalent to the functional loss of an eye.

In injuries to the optic nerve by the extension of fractures of the vault of the orbit into the optic canal, the deep situation, the great length, and the curved direction of the orbital portion of the nerve keep this part fairly well protected against direct violence. Its intracranial part is still more rarely involved, but in such a form of accident, however, the patient seldom survives.<sup>25</sup>

It is possible for an injury to the optic nerve to take place from the thrust of a sword, a foil, a knife, a scissors, an awl, an umbrella-stick, a horn, etc.; or as the result of shot and bullet wounds. In such cases the nerve, as a rule, is either bruised, torn, or cut by the instrument after it has passed through the globe or has gone between it and the orbital walls. Sometimes, the projectile, whose wound of entrance may be easily overlooked, passes so obliquely backward as to injure the optic nerve of the opposite side, and so produces a crossed type of amaurosis (see cases of Jodko, Leber, and Panas). All of these types of traumatism are very serious. The immediate and total abolition of sight generally remains permanent, except when the optic nerve has been but slightly contused or compressed; though even in such cases there is the danger of secondary atrophy from traumatic neuritis.

The nature of the foreign bodies (projectiles, fragments of glass, wood, sword-foils, knife-blades, etc.) which penetrate the orbital cavity, during quarrels, criminal assaults, and falls varies greatly.<sup>26</sup> As a general rule, even when they are of considerable size they are readily tolerated, provided they are aseptic in character. They ultimately become encysted, and produce only a certain degree of exophthalmos or a deviation of the eye. There are numerous instances in which their presence has not been suspected. To the well-known case of Higgins may be

added the account, published by Roose, of an old man, who had been wounded at Sedan, and had carried a leaden bullet two and a half centimeters long, and thirty-two grammes in weight, in his orbit for a period of twenty-two years.<sup>27</sup> Panas, likewise, cites an instance in which an officer had unconsciously borne a cylindro-conical ball in the orbital cavity for more than ten years' time.

Sometimes, on the other hand, grave complications—such as phlegmon, thrombophlebitis, erysipelas, meningoencephalitis, fatal tetanus,<sup>28</sup> complete blindness, paralytic strabismus with diplopia—may appear as a result of infection of the wound or injury to the eyeball, the optic nerve, the motor nerves, or the brain. Wicherkiewicz reports a case of a child, 8 years of age, who had fallen upon some branches and had forced a small twig of wood into her orbit, without injuring the eye. On the following day the child succumbed to an attack of acute suppurative meningitis. The autopsy showed that the piece of wood, which had been removed on the day of the accident, had perforated the cribriform plate of the ethmoid bone, and had wounded the brain near the olfactory nerve as well as completely crushing the optic nerve.<sup>29</sup>

Prognosis should consequently be very reserved, and it must not be forgotten that the removal of foreign bodies that are firmly fixed in the bony walls, or extend into the cranial cavity, exposes the patient to the chance of fatal complications (see cases of Pagenstecher, Demours, etc.).

The report<sup>30</sup> published by the author several years ago, of an hysterical servant-girl who daily introduced pieces of glass into her right lower *cul-de-sac* and orbit in order to irritate the eye, and simulated blindness so as to be able to claim heavy damages, is sufficiently interesting in this connection to deserve notice.

CASE V (personal).—Introduction of numerous pieces of glass into the orbit.

Miss X, 32 years of age, came to my office with the right eye covered with blood and complaining of severe pain. She begged me to remove several pieces of glass from behind the eyeball, which she said had entered the orbit two years before. From information obtained from the patient, and from the physicians who had previously treated her, the following history was elicited:

Family history negative: her father, mother, three brothers, and two sisters were living and were all in good health. None of them had suffered from nervous affections.

Menstruation was established at the age of twelve years, and was always regular. The patient knew she had a whimsical and irritable nature, but never had had any nervous attacks. After several improbable accounts, she finally admitted that, in the course of a dispute, she had been struck in the face by a glass of beer by her drunken master. The pieces had entered both eyes, but chiefly the right one. During several months following the accident a physician had removed six or seven pieces of glass, all having a greater length than width, and each some two centimeters long. The right eye was attacked by an iritis, and vision became markedly reduced. The physician losing her confidence, by causing too much pain during his examination, she had her master, by means of a curette and by irrigations of warm water, remove some additional pieces that could be felt at the level of the supraorbital arch. In all, about fifteen pieces had been removed from the right orbit or conjunctival *cul-de-sac*, and one from the left. Two pieces which she had preserved measured nearly four centimeters in length and twenty-seven millimeters in breadth.

The following year, she having declared on two different occasions that she had suddenly lost sight, she was taken to consult another colleague, who suspected that the case was one of simulation and made a diagnosis of intermittent amaurosis, *sine materia*, of hysterical origin. She was treated with the continuous current, and given bromide of potassium, and ordered hydrotherapy. At the end of several days' time the vision again became normal. She now asserted that the sight of the left eye had been lost six months before, as a result of a violent inflammation brought on by the presence and removal of several fragments of



glass. For about six weeks' time she suffered no pain on this side, believing that all of the pieces of glass had been removed. From the right side, a small piece had been extracted six weeks before. During the succeeding two days blood, like the pains, appeared intermittently during certain movements of the eyeball. In spite of this state of affairs she had continued to work in two different houses, courageously enduring the pains (as she said), and only going to bed a few hours before the expulsion of the fragments.

The skin of the eyelids and of the periorbital region on the left side, when carefully cleansed, failed to present any trace of a scar. One centimeter from the free border of the right lower eyelid were two cicatrices each one centimeter long and one millimeter wide, these corresponding in position with a fistulous wound of the conjunctiva. The conjunctiva and the cornea of the left eye were normal. The pupil was dilated and at its lower internal part there was a small posterior synechia. The iris was immobile. Ophthalmoscopic examination was negative. The ocular conjunctiva of the right eye was hyperemic, especially in its nasal half. Three millimeters from the cornea, situated between the internal and the inferior rectus muscles, there was a wound of the mucous membrane, about fifteen millimeters long, which ran obliquely downward and outward, this being closed by a fibrinous clot. In the lower conjunctival *cul-de-sac* there was some blood-stained mucus. The cornea, the iris, and the sclera failed to present any lesion whatsoever.

The movements of the eyeball were very painful in most directions, they becoming almost impossible when the patient made endeavors to look inward. There was no displacement of the eye. The eyelids could be very easily opened, and, on palpation of their surface, nothing could be discovered. A complete examination of the conjunctival *cul-de-sacs*, of the semilunar fold, and of the caruncle, gave negative results.

A No. 1 Bowman probe was carefully introduced into the fistulous wound, and an examination in different directions was made without obtaining the sensation of a foreign body. Cold compresses were applied and results were awaited. The next day the patient exhibited a small, quite blunt piece of glass which she said had spontaneously left the wound without occasioning great pain. At this visit the blood continued to ooze, the con-

conjunctiva was more injected, and the upper eyelid was somewhat swelled. The patient stated that she felt another fragment which was ready to be extruded. A few exploratory attempts with the Bowman probe were made without avail. Two days later the foreign material—a piece of glass—was discovered and was readily extracted by the aid of a small strabismus-hook. Every three or four days after this there were further disengagements of pieces of glass, these at times appearing every day. Some of them came out spontaneously, these being the smallest ones and those that could not be discovered during the examination even but a few hours before their expulsion. The other fragments varied in size from four to eight millimeters in length and from four to five millimeters in breadth. These were more or less easily removed with either a fixation-forceps or a strabismus-hook. The movements and the exit of these pieces of glass gave rise to the following symptoms: Pain about the eye and in the orbit, which was rendered more severe as the dimensions of the bits of glass were larger and their angles and edges were more acute; considerable swelling of the eyelids; intense conjunctival inflammation; and an effusion of bloody liquid with abundant mucus. The cornea remained intact. The pupil, which was dilated by atropine, showed the presence of two synechiæ in its lower part. Movements of the eyeball were impossible. Vision was greatly disturbed.

The patient suffered from insomnia. There were frequent attacks of vomiting, the patient being able to take only small amounts of bouillon.

As soon as the piece which was supposed to have given rise to the last grouping of symptoms came out, the blood stopped oozing, the conjunctival wound started to close, the swelling of the lids subsided, and the inflammation of the mucous membrane ceased. After this the patient was able to sleep and she no longer vomited.

A few weeks later she became delirious, so frightening the person who was watching her that the author was called for in all haste. It soon becoming evident that a case of simulation was being dealt with, a threat of the hospital and of the use of a strait-jacket put an end to the crisis. On that very night she complained of violent pains, caused, she said, by the presence of several pieces of glass which she felt were deeply seated in the back part

of her eye. Another examination failed to give anything but negative results. The following day was marked by the appearance of violent pains. The lids of the eyeball were the seat of disquieting inflammatory symptoms. At this juncture the author decided to look for any fragments and if possible to extract them. Taking as a starting-point the fistulous wound, the subconjunctival tissue between the external and the inferior rectus muscles was incised and two fragments of glass were extracted without much difficulty. One of the pieces was triangular in shape and each was greater than one centimeter in length. This laborious extraction was followed by a comparatively long period of freedom from inflammatory symptoms and the patient ceased to suffer; but, at the end of several days' time, however, she again complained of the presence of another fragment. Still many other pieces, making a total of twenty-two, were removed. At last she was told that there were doubts of her good faith, and she was made to understand that she could no longer depend upon obtaining the author's professional services.

In the hope that she would be made to confess her deceit, she was asked, nevertheless, to return, with her family, after an interval of about six weeks' time. Upon her return it was found that the fistulous wound of the conjunctiva was closed. At this visit she persisted she had lost the vision of the left eye. By the employment of suitable methods for determining simulation it was quickly ascertained that both eyes had about four-fifths visual acuity. It was very difficult, however, in spite of this evidence, to make her assert that she saw as well with her left eye as she did with her right one; and too many motives kept her from confessing the voluntary introduction of the fragments of glass.

In this case the eye remained practically intact. It is easy to understand, however, how the irritation produced by the temporary presence of the fragments of glass in the anterior part of the orbital cavity or in the fistulous wound of the conjunctiva did not produce serious lesions of the ocular envelopes. Only twice was an incision found to be necessary to remove the pieces from deeper positions, these interferences always being endured by the patient, who each time refused an anesthetic.

From the first day that I interrogated this patient speculations arose in my mind as to her being a malingerer. I constantly

asked myself how all of these glass splinters could have penetrated into the orbit at one period of her life-time. Many reasons, moreover, made me suspect the veracity of the assertions of the patient: for example, the different versions she gave of the nature of the accidents and the evident motives which she might have had for simulating.

The most careful examination of the orbito-palpebral region showed only two small cicatrices that were situated on the surface of the lower lid, these being in direct relation with a fistulous wound of the conjunctiva through which it would have been impossible for the two large fragments—that the patient showed me and for some of the other pieces which I did not see—to have entered without having produced a greater number of wounds, or at least without having made more extensive lacerations. Moreover, any splintering of the fragments against the orbital walls could not have taken place without having given rise to discoverable lesions.

The lacrymal gland and the lacrymal sac are protected by the projections of the orbital and the nasal edges of the orbit and quite readily escape injuries from contusions and direct wounds. Nevertheless, the lacrymal gland has been penetrated by foreign bodies and projectiles. Penetrating wounds of the orbit and of the external parts of the upper lid may also reach the lacrymal gland, such injuries to the gland being exceptionally followed by the formation of fistula. They are, however, of no serious consequence, unless there has been an infection of the glandular tissue or of the surrounding conjunctiva.

Notwithstanding the complete or the incomplete destruction of the gland, lubrication of the anterior surface of the eyeball is sufficiently assured by the secretion from the accessory glands (the palpebral portion of the lacrymal gland and the glands of Krause). This fortunate result, however, is not seen in cases in which the lacrymal sac and the nasal duct have been involved or when such cases are

complicated by fractures in this region. Serious disturbance with the excretion of tears is caused by a deviation and a contraction, and sometimes by an obliteration, of the excretory ducts: lesions that necessitate weeks and even months of treatment before any useful degree of recovery can be assured.

## PART SECOND.

### TRAUMATIC LESIONS OF THE EYEBALL.

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#### CHAPTER I.

##### CORNEA.<sup>31</sup>

TRAUMATIC lesions of the cornea produced by pointed, edged, and blunt instruments; by foreign bodies; or by chemical or burning substances are the most frequent forms of injuries of the eye that are seen. They may involve a part or may include the entire thickness of the corneal membrane, or they may open the anterior chamber and be complicated by disturbances of the deeper parts of the eyeball (the iris, the crystalline lens, the vitreous body, the retina, and the choroid). We shall consider here the injuries that are limited to the cornea alone.

##### (A) WOUNDS AND CONTUSIONS OF THE CORNEA.

Punctures, scrapings, and small linear sections made with clean, pointed or cutting instruments such as scissors, knives, awls, needles, or pieces of glass, etc., always heal very rapidly and often without leaving any trace that is appreciable to the naked eye. There may be, however, recurrent attacks of pain (traumatic keratalgia), as the result of superficial excoriations, such as are made by the teeth of metallic combs (Arlt,<sup>32</sup> Grandclément<sup>33</sup>), that may recur from month to month or even from year to year. Slight astigmatism is also of frequent occurrence, but in

time becomes less. Such disturbances are not, however, to be considered as permanent.

Pricking of the cornea by a metallic pen is relatively a quite frequent accident among children, and is very dangerous not only on account of an indelible form of tattooing that is produced by infiltration of the ink into the layers of the cornea, but also more greatly on account of the frequency of the occurrence of a consecutive form of keratitis of suppurative type, with iritis.

Still more serious complications, such as the loss of an eye by panophthalmitis, are to be feared. The same is true if the wound has been infected by the offending body or by the secretions of the conjunctiva, the lids, or the lacrymal apparatus,<sup>34</sup> this being especially so if the patient is old, poorly nourished, and unclean, or if he is debilitated by such conditions as diabetes and albuminuria.

It is without doubt dependent on the dyscrasia which is produced by the puerperium and lactation that the peculiar severity of scratches of the cornea by the nails of infants at the breast must be attributed. The medical expert must therefore distinguish the portion of the condition that is due to the accident from that which may have been dependent on the previous condition of the patient.

A deep irregular wound, even when it is not complicated by suppuration, heals slowly (in the course of several weeks' time), and leaves a more or less opaque and extensive cicatrix, which materially diminishes the visual acuity, particularly when the scar is situated in front of the pupil, or when it has produced an irregular curvature in the cornea. The practical effects of such a central opacity will depend upon the employment of the patient. For example, it would be much more serious in the case of a jeweler or of an accountant than it would be for a

common laborer. However, too unfavorable a prognosis must not be made, as these types of opacities have a tendency to clear, especially in very young subjects.

For varying periods of time this cicatricial tissue is less resistant to exterior violence and offers a much weakened barrier to the entrance of infectious material; and there is always the possibility of later complications, such as staphyloma and perforation of the cornea following an attack of panophthalmitis.

Contused wounds caused by pieces of stone are serious, as they are always likely to suppurate even under the most favorable circumstances, the necrotic tissues making good culture-media and thus encouraging the growth of organisms.

Penetrating, V-shaped, and circular wounds, especially those that are situated at the periphery of the corneal membrane, are usually complicated by attachments of the iris to the posterior surface of the cornea (anterior synechia) or by prolapse and incarceration of the iris in the wound. Sometimes these complications give rise to serious results, such as adherent leucoma, secondary glaucoma, and iridochoroiditis, followed by atrophy of the eyeball.

Prognosis in all such cases should in consequence be very reserved. In fact, besides delaying the cicatrization of the wound and producing a deformity or a displacement of the iris or an occlusion of the pupil, the position of the incarceration of the iris may become the starting-point of inflammatory complications which may necessitate enucleation and even menace the functional and the anatomical integrity of the opposite eye. On the other hand, in adherent leucomata or in partial staphylomata it is possible, by such an operative procedure as an iridectomy, to restore a certain degree of vision to the organ.



Among the rare complications of wounds of the cornea must be mentioned the establishment of a permanent corneal fistula which, from the presence of infectious germs, may expose the eye to suppuration, and even offer the possibility of the development of a fatal form of tetanus. Pollock has seen death occur from such a complication caused by a cut in the cornea following a stroke from the lash of a whip. A similar fatal termination has also followed an injury from a piece of steel.<sup>35</sup>

Finally, in penetrating wounds of the cornea one or more of the eyelashes may be carried into the anterior chamber, or, more rarely, they may pass into the vitreous humor, where they may act as septic foreign bodies; or they may produce simple or dermoid cysts of the iris (Rothmund, Masse).

The cornea, thanks to its elasticity, is not easily ruptured, while its contusion through the thickness of the instinctively-closed eyelids ordinarily has no ill consequences beyond the lesions to the deeper parts (crystalline lens, choroid, retina, etc.), which are the results of a violent commotion given to the globe itself.

Simple ruptures confined to the cornea are very rare, for they usually extend beyond the sclero-corneal junction. These will be considered later on.

Slight contusions of the cornea that are due to the direct action of blunt particles of wood or metal produce circumscribed losses of epithelium, though they may, if the loss of substance is not infected by pathogenic organisms, heal without leaving a trace. When, however, the traumatism is great or if the secretions of the conjunctiva and the lacrymal passages are septic, the abraded surfaces may become infiltrated and a necrosis of the corneal tissue may pass on to perforation, with the result of large adherent

leucomata or of broad staphylomata, and at times a panophthalmitis, with consequent loss of sight.

(B) FOREIGN BODIES IN THE CORNEA.

Foreign bodies situated in the cornea are seen daily in industrial centers. The most commonly found objects are cinders and small irregular fragments of steel that have been chipped from badly tempered and old tools or have been broken from masses of iron or steel. Blacksmiths, edgers, mill-wrights, mechanics, and locomotive firemen are the most exposed classes of subjects. Those who work with sheet-iron, copper, and tin are, on account of the malleability of these metals, less liable to injury. Knife-sharpeners and grindstone-workers, especially if they are not protected by proper spectacles,<sup>36</sup> are very often subjected to injuries of this nature, not only by metallic particles, but by pieces of sandstone or emery.

Machine-tools, lathes, and planing machines, in particular, throw off fragments of hard and brittle metals, such as cast-iron and bronze. By some it is deemed justifiable to place the responsibility upon the owner, if the tools are badly tempered and consequently are dangerous to use.

Small metallic particles imbedded in the cornea may cause so little annoyance and reaction that the patient may be unaware of their presence. In fact, a number of cases have been reported (Velpeau, Grand, Yvert, Knapp, Magnus, etc.) in which aseptic bits of steel and glass have been encysted for months and years.

As a rule, if the foreign body is at once removed in such cases, the patient can return to work in one or two days' time, but if there be any neglect of the injury the eyes may be incapacitated from use for a period of several weeks.

On the contrary, the gravity of the accident is rendered far different if the foreign body has been deeply seated or if it has severely contused the corneal membrane; and, above all, if the foreign material has been charged with septic organic matter. In a work published in 1888<sup>37</sup> the author noted such types of serious complications in five out of one hundred and eighty cases of foreign body in the cornea. In this grouping infectious keratitis, followed by loss of the eye, appeared once; almost total staphyloma following an infectious form of keratitis was seen once; while dense cicatricial leucomata, with reduction of visual acuity to one-half of normal, were found in three instances.

A point to be noted is that these complicated cases were all seen in "edgers." These men, by means of a hammer and a chisel, remove the narrow projections which are formed on the surfaces of molded casts, these pieces being usually covered with a sand mixture, which is composed of clay and fine charcoal, mixed with various excreta. In such cases the corneal wound becomes quickly infected, and, as in Stromeyer's experiments, severe ulcerative keratitis with hypopyon, followed by rapid destruction of the substance of the cornea, generally appears. The form and the nature of the foreign body are also of considerable importance. Irregular fragments of stone or metal with obtuse angles contuses the cornea much more than sharply edged and polished particles of steel or iron, the contused wound that is produced by the former type of agents retaining any septic material much better than the form of injury that is produced by the latter.

Finally, the danger of infection of a corneal wound is much increased by the presence of a dacryocystitis and a muco-purulent conjunctivitis, especially in alcoholic and senile subjects. As early as 1873 the author<sup>38</sup> showed

the marked influence that is exercised upon the cicatrization of corneal wounds by diseases of the conjunctiva and the general condition of the patient.

(C) BURNS OF THE CORNEA.<sup>39</sup>

It has been noted in a previous chapter that in burns of the face the conjunctiva, the cornea, the sclera, and the eyelids are frequently involved in association. The cornea, however, may be alone injured by incandescent bodies, while caustic fluids nearly always extend their action to the oculo-palpebral conjunctiva.

The prognosis of isolated burns of the cornea varies according to their extent and in accordance with the nature of the substance from simple desquamation of the epithelium (burns of the first degree) to more or less extensive ulceration and necrosis with perforation and loss of the eyeball. It is best to avoid giving a favorable prognosis too quickly. Eyes that are apparently but slightly injured may be lost in several weeks' time, the lesions often being deeper than the early symptoms have apparently indicated. On the contrary, it is surprising at times to find a return of the cornea to its normal condition in cases in which the injury seemed to have been very serious. Certainty of opinion as to the degree of corneal burns is, in fact, a difficult task. If, however, the cornea presents but a slight amount of loss of epithelium, or evidences but a thin gray opacity, through which the pupillary margin of the iris can be seen, a cure may be generally expected by treatment in a few weeks' time.

Acids (particularly sulphuric acid), boiling water, and ignited gases usually give rise to marked disturbances, such as necrosis of the cornea, atrophy of the eyeball, adherent

leucomata followed by glaucoma and sympathetic ophthalmia,—frequently leading to absolute loss of vision.

Among the superficial and the benign forms of burns are to be included those which are produced by particles of phosphorus, grains of burning powder, sparks, and incandescent metallic chips from slag or those that are thrown off from slag, blacksmiths' hammers, and heated metal. In none of the cases of these types that have been observed by the author has there been any tendency to severe inflammation (keratitis with hypopyon) such as Terrier and Latour Saint-Ygest have noted as appearing after injuries from ignited coke and coal.<sup>40</sup>

Incandescent or molten metals cause both superficial and deep burns, these being in accordance with the nature of the metals and in direct relation with their differences of points of fusion. Brass, iron, steel, and copper—which fuse at much higher temperatures than antimony, lead, zinc, and tin—burn more deeply.

When the burn is superficial the corneal epithelium is raised and forms a small, whitish pellicle, which resembles coagulated albumin or the white of an egg.<sup>41</sup> This appearance may be mistaken as an expression of a serious lesion, but in the superficial form of injury the membrane is easily removed by slight pressure. In addition, there is hyperemia of the conjunctiva, with photophobia and pain. Recovery takes place in a few days' time.

Deep burns by metals in the state of high fusion convert the injured portions of the cornea into grayish-yellow eschars, the sloughing of which is almost certain to be followed by perforation of the eyeball with panophthalmitis.

On account of the continual employment of slacked lime in mortar, cement, etc., burns caused by this substance are of very frequent occurrence.

More rarely, particles of quick-lime are thrown into the eyes and either destroy small portions of the cornea or convert the entire membrane into a pulpified mass.<sup>42</sup>

The prominent feature of burns by slaked lime is a calcareous infiltration of the cornea, with destruction of its layers to depths that vary with the intensity of the injury. Only the very slight amounts of deposition are reabsorbed or are removed by separation of the superficial eschar. In the majority of cases an intense degree of inflammation persists for a period of many weeks, and in some instances, corneal vascularization, which is necessary for the repair of the membrane, may remain in the form of a pannus. Extensive and deep destruction of the corneal tissues may menace not only the cornea itself, but may also affect the entire organ.

Burns by lime have an important place among the lists of different types of traumatism to which workmen endeavor to attribute a lowering of visual acuity that is largely due to other causes and for which they lay claim to heavy damages. The following report is one that has been made by the author to an insurance company, in a case of this character:—

CASE VI (personal and unpublished).—Burns of both cornea by lime-dust. Medico-legal report.

I have the honor of submitting to the company the following report upon the visual function of Mr. H., aged 65 years, a workman in the sugar-refinery of X, who is said to have gotten lime-dust in both eyes on the night of October 25, 189-.

*Previous History.*—As H. has varied considerably in his responses, too much credence cannot be placed in his statements about the accident and its consequences. However, from his various declarations, it appears that he was injured during the night, and continued to work until daybreak; that he has been at the hospital in X for a period of three weeks, for treatment of the

*right* eye; and that the vision of the *left* eye was reduced to perception of light before the accident.

*Present Condition.*—The patient was seen on the 26th of last December and again to-day, January 3d. When first seen he had the posture of a blind man, was led by the hand, and was apparently unable to walk alone. Careful examination has shown that the sight of the left eye is completely abolished. After declaring at first that he had only an uncertain perception of light, he finally has been able to see to count fingers at a distance of thirty centimeters without difficulty. Examination of the visual field has been exceedingly difficult, and the confused replies of the patient have not permitted me to determine its limits.

Examination of the left eye shows that there is a slight vascularization of the oculo-palpebral conjunctiva, without any apparent secretion. No trace of a cicatrix nor of any adhesions in the *cul-de-sac*, such as are usually found in severe burns by caustic substances, can be determined. The anterior segment of the eyeball is destroyed. This old lesion is probably the result of an intense degree of corneal inflammation which has invaded successively the deeper parts of the eye (iris, etc.). Whatever it may have been, the atrophied eyeball is not at present the seat of any irritative processes. Careful palpation fails to reveal any painful points. The patient states that he has never had pain in either eye or in the surrounding parts.

After the instillation of several drops of atropine into the conjunctival *cul-de-sac* of the right eye in order to study the condition of the iris and the deeper parts of the organ, the following lesions were found: Toward the outer edge of the eyebrow is a cicatrix that is tattooed in black, which, like a similar scar that is situated at the root of the nose, is superficial and non-adherent, and has no connection with the present accident. There is a slight injection of the oculo-palpebral conjunctiva, without any catarrhal secretion. The center of the cornea is the seat of a superficial opacity, while a smaller one is situated in the periphery of the membrane. These opacities are the results of an inflammation of the cornea which are, perhaps, traumatic in nature (that is to say, are due to the action of lime-dust). The neighboring conjunctiva and the peripheral parts of the cornea are apparently unaffected. The limited and the superficial characters of the burn are in contrast with the signs of previous inflammation of the iris, the traces

of which are to be seen in the form of a synechia at the external pupillary margin. In addition, the pupil is irregular; the iris is slightly discolored and it reacts very sluggishly to light-stimulus and to atropine. The media and the deeper parts of the eye are quite difficult to examine, on account of the central opacity of the cornea; they apparently, however, fail to present any pathological alterations. The movements of the eye are free in every direction. There does not seem to be any strabismus.

The following conclusions may consequently be drawn:—

1. Vision with the left eye is abolished. There is no reason to think that the left eye, which is degenerated, and has been quiet until the present time, will in the future show any inflammatory symptoms or that it will have any deleterious influence upon its fellow.

2. The condition of the right eye does not account for the almost complete blindness of which the patient complains. The central opacity of the cornea and the old iritis undoubtedly cause a considerable disturbance of vision, but the patient has certainly a sufficient degree of visual acuity to walk alone during the day, and perhaps enough to undertake coarse work.

3. It is relatively easy for the expert to determine the vision of an injured eye when the other eye is normal, but it is very difficult to obtain any definite results when the latter is or is stated to be blind. It is likewise exceedingly difficult for him to calculate the condition of the eyes previous to an accident, and to estimate the damage that has been done by any traumatism. In the present case, it is very probable that the right eye had already been the seat of an inflammation of the iris, perhaps also of the cornea, and that, if the alleged accident really occurred, the powdered lime produced a very slight degree of inflammation of the cornea and of the conjunctiva. This conclusion is justified by the character of the corneal leucoma.

In a similar case the author was associated with his colleagues Cuignet and Dujardin in the examination of Mr. B. for the civil court at Lille. Two years previously the patient's left eye had been burned by a jet of caustic soda while he was fixing a stop-cock. B. claimed that he was blind, as a result of the accident. The *résumé* of the



examination and the conclusions presented in the report are as follow:—

CASE VII (personal and unpublished).—Burn of the left cornea by a jet of caustic soda. Simulation of amaurosis of both eyes. Medico-legal report.

*Right Eye.*—Aside from a scarcely perceptible central opacity of the cornea, which is probably due to an inflammation which occurred during childhood, the right eye is absolutely normal.

*Left Eye.*—The conjunctiva and the lids fail to present any evidences of a burn. A whitish leucoma occupies the infero-internal third of the cornea, and the limbus at this point is the seat of a traumatic pterygium. The rest of the corneal membrane is quite transparent. There is no adhesion between the iris and the cornea; consequently it may be fairly stated that the latter was not perforated as a result of the traumatism. The iris does not show any trace of a former inflammation. The pupil is circular and the iris reacts well to light. The media and the intraocular membranes are normal.

*Conclusions.*—The lesions found are not sufficient to cause the complete abolition of sight of which B. complains. The results of the burn of the left eye are serious. The opacity of one-third of the area of the cornea, with the flattening of its surface, gravely compromises the vision of this eye, but is not sufficient to produce blindness, nor to affect so seriously its fellow-eye, which was not involved in the burn, as is claimed. We must therefore assume that B., previous to the accident, had a disease of the organ of vision, though difficult, it is true, to determine.

While cases of amaurosis without lesion have been seen, however, there is no case of partial burn of the cornea without perforation of which we are aware that has led to the total loss of sight of both eyes. A similar burn in a healthy eye undoubtedly would have produced a considerable degree of reduction of vision, but it would have never been so marked as has been here asserted; and, further, with so much transparent cornea it would be possible to improve it by making an artificial pupil.

The experts, while not ignoring the severity of the burn of the left eye, refuse to consider it as the cause of the patient's asserted blindness.

Powder-burns of the cornea may be due to the presence of the carbon-grains themselves or to the gases that have been generated during the explosion of the powder. As a rule, the grains form bluish-gray opacities, and, in proportion to their number, produce variable degrees of disturbance of vision. Sometimes the cornea may ulcerate and give rise to perforation. Moreover, laceration may be caused by gases that have been generated during mine-explosions. (This subject will be again referred to in the chapter on "Injuries to the Entire Eyeball.")

## CHAPTER II.

### SCLERA.<sup>43</sup>

INJURIES to the sclera in themselves are not serious. They are, however, usually combined with lacerated or with incised wounds of the cornea, and of the choroid and retina (penetrating wounds of the eye). Prognosis in these types of cases is rendered still more serious by the entrance of various kinds of foreign bodies.

Exceptionally the sclera is alone involved, the force of the foreign body being spent while passing through the external layers of this covering. Such forms of injuries will not detain us, as the healing of non-penetrating wounds of the sclera, unless infected or very extensive and complicated,—as, for example, by prolapse of the choroid,—is very rapid.

Foreign bodies in the sclera and burns of the sclerotic membrane will require but brief consideration.

Foreign bodies (metallic particles, grains of powder, small fragments of glass, etc.), are sometimes imprisoned in the sclera without perforating it. Pieces of metal and fragments of glass when superficially situated are easily removed. Should the foreign materials be grains of powder, it is much the best, if they are very numerous, to leave them alone, for any attempts that may be made to extract them may prove to be more injurious to the patient than the results of any staining that may arise from their presence.

It has been previously mentioned that certain metals—such as brass, iron, and copper, but



Three patients with the minor class of injury who were treated by the author recovered without the slightest diminution in central visual acuity and without any appreciable decrease in the visual fields. In one of these cases the sclera had been perforated in the equatorial region through the upper lid, by the point of a large saddler's awl. There was a slight prolapse of the vitreous body. In the other two cases the scleral pricks were caused by ordinary sewing-needles.

Small, penetrating wounds extending in meridional directions, and those which are situated in the posterior hemisphere of the eyeball, are said not to be as serious as was formerly considered. They heal quite rapidly and without any complications when they are aseptic and have not been complicated by a marked loss of the vitreous humor. It must not be forgotten, however, that there may be a subsequent contraction of the visual field, followed by complete loss of vision, as the result of detachment of the retina, which is due to degeneration of the vitreous humor and cicatrization of the scleral wound.

Case No. 8 in de Schuttelaere's thesis (penetrating wound of the left cornea and sclera; scleral suture; recovery with preservation of some vision) had a visual acuity which equaled one-third of normal four months after the original accident, while, at the end of a year's time central vision became reduced to one-fifteenth of normal and the visual field was abolished throughout more than three-fourths of its ordinary extent. The tenth case (penetrating wound of the right sclera caused by a fragment of steel; conjunctival suture; recovery) had a normal central acuity of vision at the time of the healing of the scleral wound; that is to say, one month after the accident. A slight detachment of the retina situated at the

site of the wound was found by ophthalmoscopic examination. Nearly three years later it was noticed that the retinal detachment had become markedly increased and that the inner half of the visual field was destroyed.

In a recent case of penetrating wound of the sclera the author submitted the following report:—

CASE VIII (personal and unpublished).—Penetrating wound of the sclera. Suture of the conjunctiva. Recovery. Medico-legal report.

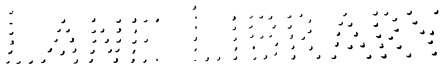
R., a 27-year-old man, was struck on the left eye by a small piece of sheet-iron, which was immediately removed by one of his comrades. The patient did not feel any severe pain, but he said that he saw indistinctly with that eye, and that the organ seemed to him to be somewhat smaller than its fellow.

In the lower internal part of the globe there was a penetrating wound of the sclera which was about one centimeter in length. It commenced about three millimeters behind the edge of the cornea and ran perpendicularly to the cornea, presenting between its slightly-opened lips a moderately-sized prolapse of the vitreous humor. The conjunctiva was detached and formed a small flap with its base placed upward. The ophthalmoscope revealed the presence of a hemorrhage into the vitreous humor.

After irrigation of the affected parts with a 1 to 5000 strength solution of corrosive sublimate, the patient was chloroformed, the conjunctiva at the lower part of the wound was freed, and the flaps were carefully approximated by two fine carbolized-catgut sutures. During the operation there was a slight loss of vitreous humor. Irrigation with occlusive dressings saturated with corrosive sublimate were employed.

In three days' time the stitches were removed. There was no inflammatory reaction and the patient did not complain of any pain. Compression was maintained for several days.

Fifteen days later the wound seemed to be healed and the injection had almost disappeared. The intraocular hemorrhage, however, had not been entirely reabsorbed and the eyeground could be illuminated only with difficulty. At this time the patient could hardly see sufficiently to distinguish fingers.



Fifteen days after this the patient could easily count fingers at a distance of five meters.

Six weeks later visual acuity had risen to a degree that was equal to one-third of normal, this improvement, however, being associated with a marked diminution of the visual field above and to the outer side.

The condition eight days following (the time of making the report) was as follows: The right eye was emmetropic, its visual acuity and field of vision being normal. (The patient stated that he had not had any trouble from this eye since the date of the accident.)

At the site of the wound in the left eye there was a slate-colored and slightly-depressed cicatrix which was adherent to the conjunctiva. There was not any tendency to the formation of a staphyloma. The anterior chamber was of its usual depth. The pupil was normal in size and the iris responded just as well as its fellow of the opposite side.

The media were clear. Examination with the ophthalmoscope showed an atrophic spot which was surrounded by pigment situated in a position corresponding to that of the former solution of continuity. The retina internal to the atrophic spot was detached. The rest of the fundus of the eye failed to present anything in particular.

The acuity of vision equaled three-fourths of normal and the visual field was contracted above and to the outer side.

#### CONCLUSIONS.

Question: Is the lesion a definitely-characterized traumatism? Did the patient have any pre-existing disease of the eye which could have an influence upon the present results?

Answer: R. has a penetrating wound of the left sclera, resulting from the impact of a small piece of sheet-iron. No trace of a congenital affection of the left eye or of an acquired one before the accident has been found as the result of successive examinations.

Question: What are the consequences of this injury? Is the present condition permanent? Is the condition likely to become better or worse?

Answer: Direct vision of the left eye is at present diminished

by about one-fourth of what is considered as normal and the visual field is markedly contracted in its upper outer part. Under these conditions the earning capacity of R. is certainly decreased, but not to such an extent as to debar him from resuming his former occupation.

I consider the present lesions permanent, and not likely to be improved by the influence of time or by any treatment whatsoever.

It is possible, however, for vision in this eye to be entirely lost as the result of a progressive detachment of the retina.

Large, irregular, gaping wounds and those that are complicated by associated injuries to the cornea, the iris, the ciliary body, the choroid, the retina, or the lens, and are associated with the destruction of much of the contents of the eye, usually result in absolute loss of the injured organ after many months of treatment and suffering. In this respect, deep sclero-corneal wounds, which reach the subjacent parts and in particular the ciliary body, are of extreme gravity, while the loss of the other eye from sympathetic disease is always to be feared.

In his report upon "The Surgical Intervention in Wounds of the Eye with Penetration of Foreign Bodies,"<sup>45</sup> Coppez collected 720 cases of penetrating wounds of the eyeball, 96 of which were accompanied by entrance of foreign materials. In 421 cases the eyes were lost, while in 52 the patients became blind. Various types of sympathetic complication were seen in 14 per cent. These figures are of grave prognostic importance.

Some of the complications of penetrating wounds of the sclera are immediate, while others develop subsequently.

Marked loss of the vitreous humor, intraocular hemorrhage, incarceration of iris-tissue, luxation and opacification of the crystalline lens, primary detachment of the retina, and the presence of foreign bodies in the interior of the



eye practically constitute the first class, while suppuration, iridochoroiditis, late or secondary detachment of the retina, sympathetic conditions, and bulbar atrophy belong to the second category.

Free intraocular hemorrhage due to a wounding of the choroid with a considerable loss of the vitreous humor is often followed by a detachment of the choroid and of the retina and by violent inflammatory symptoms,—the gravity of which should not be underestimated. Moreover, any vitreous humor that may be inclosed within the wound may become organized and form a part of the cicatricial tissue, which, by contraction, may, several weeks or months after the accident, produce detachment of the retina at a point that is situated opposite the seat of injury. In consequence, in spite of an apparently satisfactory recovery, the medical expert must not forget that any loss of the vitreous humor, no matter how small, may produce a partial loosening of its posterior segment (Ivanoff, de Gouvea, etc.), as a result of which the patient may be threatened with retinal detachment and consequent loss of vision.

Not less serious are the consequences of complete expulsion of the crystalline lens, which in some fortunate instances has been followed, it is true, by a partial and even a complete re-establishment of vision (cases of Dixon, de Trélat, de Gouvea, etc.<sup>46</sup>). As a general rule, however, total expulsion of the crystalline lens is the result of a violent traumatism, and is generally complicated by a large hernia of the iris, prolapse of the vitreous humor, and detachment of the retina.

If the crystalline lens is dislocated into the vitreous humor, it may provoke an attack of iridocyclitis or set into action a series of glaucomatous symptoms. (Traumatic cataract will be considered later.)

Incarceration of the iris, although much less dangerous at the present time than formerly (thanks to antiseptis), frequently leads to the formation of a staphyloma which may become a source of constant irritation.

The prognostic importance of primary detachment of the retina varies in accordance with its methods of production and by the degree of loss of vitreous humor. In the former case the detachment may be of the same size as the wound in the sclera itself, but in the latter instance the most frequent result will be complete loss of vision.

Deep penetration of foreign bodies often has the most dire bearing upon the question of prognosis. (This complication will be studied in the chapters on "Foreign Bodies in the Choroid," "In the Retina," "In the Crystalline Lens," and "In the Vitreous Body.")

The late complications which have been enumerated are much more serious, since they compromise not only the existence of the injured organ, but sometimes menace the other eye as well.

The multiplicity and the importance of these different forms of lesions should make the physician who is consulted at the time of the injury careful in estimating the possible consequences of penetrating wounds of the sclera. In any case, on account of the possibility of later complications, the medical expert cannot lay down a positive judgment before a lapse of several months' time.

#### (B) RUPTURES OF THE SCLEROTIC.

The sclera is frequently ruptured by violent contusions of the eyeball by stabs from cows' horns; or by blunt bodies such as the end of a cane, an umbrella, a stick, or a fist; or by falls against pieces of furniture, etc. In the

great majority of such cases the wounding agent inflicts its blow from below and without, where the bony orbital edge recedes and leaves the eyeball partially exposed. The wound generally assumes the form of a slender crescent.

This solution of continuity, which is most often indirect and due to *contrecoup*, involves, according to the degree of violence of the traumatism, one or more of the ocular membranes. It is generally situated at two or three millimeters' distance from the corneal edge (the superior internal part) and is parallel with the corneal limbus, which is the point of least resistance: that is, at or near the canal of Schlemm.<sup>47</sup> Moreover, the sclera is ruptured more readily in adults and in aged subjects in whom the ocular coats have lost the greater part (if not all) of their elasticity.

On account of its laxity the conjunctiva usually remains intact, thus protecting the scleral wound from infection. In consequence, therefore, there is an absence of suppuration, which accounts for the success of the plan of conjunctival suturing to which the great majority of surgeons of to-day have recourse in cases of injuries to the sclerotic. In addition, any inflammatory reaction which may accompany either ruptures or penetrating wounds of the sclera is generally very slight, this being dependent, in measure, on a diminution in the intraocular tension.

If the choroid is not involved in the accident, there will be, as a rule, a displacement of the internal portions of the eye toward the position of the solution of continuity, the equilibrium between the intraocular and the extraocular pressures being destroyed. In such cases the iris and the choroid form a bluish, slate-colored hernia which is situated in the wound and which, after cicatrization, may give rise to a scleral staphyloma, with all its

troublesome consequences. The crystalline lens may be pushed toward the wound, and, on account of rupture of the zone of Zinn, may become opaque. At times by compressing the iris and the ciliary body the dislocated lens gives rise to an iridocyclitis which may sympathetically menace the eye of the other side (Arlt). Although the retina may not be included in the wound, yet it frequently becomes detached: a lesion which is as serious as its laceration. Wounds of the ciliary body necessarily most seriously complicate the prognosis of the condition.

When the traumatism has been more violent and the sclera and the choroid have been ruptured, the crystalline lens, with a part of the vitreous humor, may be expelled at the same time. The crystalline lens, however, sometimes remains incarcerated between the lips of the wound, though ordinarily it is luxated beneath the conjunctiva, which forms a receptacle for it. At times it is extruded through a rent in the conjunctival membrane. Contrary to what happens in cases of luxation of the crystalline lens into the vitreous body or into the anterior chamber, reactionary symptoms are not often complained of, and, after absorption of any intraocular hemorrhage and removal of the encysted lens, good vision may be secured for several years at least<sup>48</sup>—provided that too many intraocular lesions have not been produced.

Unfortunately, in the great majority of such cases recovery is only transient, a permanent loss of the visual function being the usual consequences of a phthisis of the eyeball.

## CHAPTER III.

### IRIS.

THE iris may be indirectly involved by contusions of the eyeball, or it may be directly injured by wounds extending through the coats of the eye from pointed or cutting objects, or by the entrance of foreign bodies.

#### (A) INJURIES TO THE IRIS BY CONTUSION.

Direct traumatisms to the eyeball (for example, those arising from blows of fists; strokes from pieces of wood, iron, stone, bats, snow-balls, or bullets; or jars from falls upon the periorbital region) may produce serious lesions of the iris, such as partial or total detachment of its tissues at its circumference: known, respectively, as *iridodialysis* and *irideremia*. These results are especially the case if the sphincter muscle of the iris-membrane is strongly contracted at the time, or if the pupillary margin of the iris is fixed by adhesions.

Iridodialysis (not to be confounded with any congenital anomaly) produces very little disturbance of vision, except when it is so large as to form an eccentric pupil through which the patient can simultaneously see.

The production of irideremia is quickly followed by a marked dazzling and a blurring of vision, this being particularly so if the eye is not normal in its refractive power. This generally appears after the ordinarily present hemorrhage into the anterior chamber is absorbed, and the detached portion of the iris shrivels and becomes degenerated. In some cases the torn parts of the iris-tissue may be ex-

pelled through a scleral rupture, the mass either being alone or accompanied with the crystalline lens.<sup>49</sup>

Much more rarely a retroversion of the iris, with a backward luxation of the crystalline lens, is found. This condition can be readily distinguished from either an iridodialysis or an irideremia by an ophthalmoscopic examination. In retroversion the ciliary processes are concealed by the iris, but in iridodialysis and irideremia the processes of the ciliary body can be easily seen as broad, black bands that are situated against a red eyeground. Fissures of the pupillary margin of the iris<sup>50</sup> and lacerations of the iris-substance creating supplementary pupils and simulating congenital polycoria<sup>51</sup> are comparatively rare conditions, and are to be distinguished from congenital forms of fissures in the iris by the presence of hyphemia, paralytic mydriasis, and synechia. Moreover, colobomata are generally bilateral, are usually situated in the median line below or in the lower inner quadrant, and, as a rule, are associated with other ocular malformations, such as coloboma of the choroid, the crystalline lens, or the eyelids; zonular cataract; microphthalmos; harelip, etc.

These various lesions produce more or less noticeable deformities and give rise to disturbances of vision (such as dazzling and monocular diplopia); but, unless they extend to the deeper structures of the eye, its functions are not, as a rule, seriously disturbed.

Inflammatory reaction in simple traumatism of the iris is usually insignificant, and ordinary extravasation of blood rapidly disappears. However, an attack of severe iritis or an iridocyclitis may follow an iridodialysis, or the traumatism may have been so pronounced as to produce such conditions as rupture of the sclera, luxation and opacification of the crystalline lens, laceration of the cho-

roid and retina, detachment of the retina, hemorrhage into the vitreous humor, etc.; so that in any given case a prognosis cannot be offered until all hemorrhagic absorption has been completed.

(B) WOUNDS OF THE IRIS MADE BY POINTED AND CUTTING INSTRUMENTS.

Wounds from fine-pointed instruments, such as needles, awls, pens, etc., are rarely limited to the tissue of the iris itself. In such cases, however, unless the wound is infected, there is, as a rule, only a slight and temporary hyphemia without any inflammatory reaction. Supplementary pupils are occasionally formed, as in a case that has been described by Fano.<sup>52</sup>

More frequent and much more serious are wounds that are complicated by an injury to the crystalline lens; but in these cases the seriousness of the accident depends upon the character of the injury to the lens.

Such injuries rarely leave the crystalline lens intact. The author has seen a case of simple wound of the cornea and the iris, in a medical student, from a fragment of glass, caused by an explosion of a glass vessel. Down and out from the pupillary margin there was a secondary oval pupil separated from the natural pupil by a bridge of iris-tissue which was one-half millimeter broad. One year later the site of the old wound of the cornea was shown by a white line, and although there were two pupils there was no dazzling and no monocular diplopia. The media of the eye were transparent, while vision with a convex cylinder of three diopters' strength with its axis at forty-five degrees equaled one-third of normal.

The innocent character of such wounds is well shown

by the results of the operation for iridectomy, serious sequels, as a rule, only being present when the wounding agents are septic in character.

(C) FOREIGN BODIES IN THE ANTERIOR CHAMBER  
AND THE IRIS.<sup>53</sup>

Particles of iron, steel, copper, stone, or glass, grains of powder, etc., usually enter the anterior chamber or become fixed in the iris after having perforated the cornea. Very rarely they pass through the eyelids and the sclera, injuring the crystalline lens during their passage.

At times these foreign bodies become encysted in the iris-tissue or they become caught in the angle of the anterior chamber, and are tolerated for years without any marked inflammatory reaction.<sup>54</sup> Some metals are oxidized and may undergo dissolution. Far more frequently, however, they give rise to a subacute or a plastic form of inflammation which—involving the cornea, the iris, and the ciliary body—produces atrophy of the eye, and in some cases, if enucleation is not performed or if the foreign material is not extruded by suppurative processes, a sympathetic ophthalmia may take place. At times the cornea may be but partially destroyed. In these forms of injury an iridectomy may greatly improve vision.

The prognosis in all such cases, unless the foreign body can be immediately removed, is very serious. If the offending material be extracted, recovery is generally prompt, and any visual disturbance will, as a rule, be quite insignificant.

CASE IX (personal and unpublished).—Foreign body (chip of steel) fixed at the lower external part of the left iris. Suppurative iritis. Extraction of the foreign material by an iridectomy. Cure.



On the twenty-seventh of August, 189-, A. C., a weicher, was wounded in the left eye by a chip of steel. Although suffering severe cephalalgia, the patient continued to work. On the day following the accident the author found the following conditions: Intense pericorneal injection, which was more pronounced in the infero-external part of the eye. Corresponding in position to this area of injection a scarcely-visible wound of the cornea, one and a half millimeters from the limbus, could be seen. Oblique illumination revealed the presence of a piece of metal the size of the head of a pin situated on the anterior surface of the inflamed iris directly opposite the corneal wound. The pupil was contracted, and there was a beginning hypopyon. The patient complained of marked pain and photophobia.

The foreign body, together with the portion of the iris upon which it rested, was immediately removed. Compresses saturated with a solution of boric acid were applied and atropine was instilled four times daily.

Eight days later the iritis had yielded. The patient was discharged from the hospital. Three weeks afterward vision of the affected eye, with the aid of a convex spherical lens of one-half a diopter's strength, equaled five-sixths of normal. The patient complained of but a slight degree of dazzling.

It must be remembered that prolonged operative procedures may produce a traumatic cataract or give rise to a violent degree of iritis, reducing vision and necessitating several months of treatment.

## CHAPTER IV.

### CHOROID AND CILIARY BODY.

THE anterior part of the choroid, designated as the ciliary region, has always been considered a situation to which the expression of *noli me tangere* aptly applies, while clinical observations have shown that wounds of the ciliary body and foreign bodies in it are among the most serious disturbances of the ocular globe. In fact, except in rare instances of encystment<sup>55</sup> or of immediate extraction of the offending material, the eye is almost always lost by the subsequent production of a suppurative iridochoroiditis and panophthalmitis; and, moreover, the condition is frequently the cause of a sympathetic form of ophthalmia in the fellow-eye. Five well-known cases of sympathetic disease studied by Coppez were all due to the effects of the presence of foreign bodies in the ciliary region.

The employment of antiseptics, however, has diminished considerably the frequency of these formidable complications, and it is now well recognized that with a small, cleanly-incised wound of the ciliary body the patient has a good chance of escaping the various forms of sympathetic lesion, provided, particularly, if he be in good health and if the wound has remained uninfected. Even when there is infection, Abadie and other surgeons<sup>56</sup> have been able to combat successfully the evil results by such remedies as antiseptic irrigations, intraocular and subconjunctival injections of corrosive sublimate, and deep applications of the thermocautery. Ohlemann's statistics of

566 cases of severe wounds of the eye, in 100 of which the wound was infected or was complicated by the presence of a foreign body, and in which there were but 2 cases of sympathetic disease, distinctly showed that very much in regard to prognosis depends upon the general condition of the patient.

Penetrating wounds of the sclero-corneal margin are often followed by the condition known as "iridochoriocyclitis." This may be acute or chronic in type. As a rule, it ends in atrophy of the injured eye and in one of the plastic forms of sympathetic cyclitis of the opposite eye, these results often appearing after months of severe suffering, which is the accompaniment of a series of inflammatory attacks. Suppurative "iridochoriocyclitis" rarely produces sympathetic ophthalmia.

The following case is a good example of the favorable termination of a wound of this latter type:—

CASE X (personal and unpublished).—Penetrating wound of the right eye involving the sclero-corneal region and the ciliary body. Recovery.

On the eighth of August, 189-, J. L., a 30-year-old man, was struck in the right eye by a piece of glass. He received medical treatment at once.

He was seen by the author eight days later. At that time there was a wound of the cornea which was two centimeters long, extending obliquely downward and inward into the ciliary region. The tension of the globe was somewhat below normal. The iris was prolapsed, and the pupil was reduced to a minute oval slit which was displaced toward the corneal wound. There was no marked inflammatory reaction, and the patient had not suffered any acute pain. The eye had been treated by leeching and the constant application of compresses which had been soaked in a solution of boric acid. This treatment, with the addition of irrigations of the conjunctival *cul-de-sac* with corrosive-sublimate solutions of 1 to 5000 strength and instillation of atropine four times

daily, was continued. The prolapsed iris was not excised. The left eye, which had never given the patient any trouble, had been phthisical since infancy.

No suppuration occurred and the iris-prolapse gradually disappeared, until by the 20th of November of the same year the wound had healed without any tendency to staphyloma. The iris was adherent to the cicatrix. The details of the eyeground could be readily seen through the distorted pupil. Vision corrected with a convex spherical lens of two and a half diopters' strength equaled five-sixths of normal.

Wounds of the posterior segment of the choroid always indicate a considerable degree of traumatism; and, as has been stated in a previous chapter, they heal rapidly when they are aseptic in character and when there is not any marked loss of the vitreous humor.<sup>57</sup>

#### (A) TRAUMATIC HEMORRHAGES OF THE CHOROID.

Hemorrhages of the choroid may be produced by any form of severe blow upon the eye, the temple, the forehead, or the eyebrows by fists, pieces of iron or wood, etc., or by direct penetrating wounds. They are most frequently situated in the anterior part of the membrane in or near the ora serrata. A marked predisposition to these types of extravasations exists in patients who have high degrees of myopia or who are suffering from heart or lung troubles, arteriosclerosis, uterine affections, anemia, etc.

These facts are of considerable importance to the expert. Sometimes the extravasated blood infiltrates through the tissues of the choroid itself (interstitial hemorrhage), or it collects in the suprachoroidal spaces between the choroid and the sclera. Ordinarily the hemorrhages are not serious and do not disturb vision unless they are very extensive or are situated near the posterior pole of the eye (a rare condition). The interstitial types of hemorrhage are

slowly absorbed and often leave behind them white atrophic areas that are surrounded with pigment.

Hemorrhagic detachment of the choroid, by rupture of an important ciliary vessel, usually terminates in phthisis bulbi from a gross form of iridochoroiditis. Profuse extravasations of blood may also lead to detachment of the retina,<sup>58</sup> and sometimes to its rupture.

According to de Wecker, blood may find its way into the vitreous humor between the fibers of the optic nerve, without rupturing the retina. Whatever may be the course of the extravasation, the prognosis of subretinal hemorrhages and of those that penetrate into the vitreous chamber is very serious. On the contrary, however, if the patient is young and healthy and if the extravasation of blood is limited in amount and extent, the blood may be absorbed, all scotomata disappear, and partial vision be restored.

CASE XI (personal and unpublished).—Multiple traumatic hemorrhages into the choroid and the vitreous humor. Recovery.

On the eighth day of March, 189-, A. W., a 28-year-old blacksmith, was struck on the left eye by a large piece of iron. Two hours after the accident the lids were slightly swollen. There were subconjunctival ecchymoses situated to the outer side of the cornea and the pupil was irregularly dilated. Vision was markedly decreased. An examination with the ophthalmoscope revealed the presence of a series of minute hemorrhages that were situated in the anterior part of the choroid, these varying in size from that of a pinhead to that of a pea. Over these hemorrhages the retinal vessels passed intact. The vitreous humor was filled with numerous floating opacities.

Three leeches were applied to the left temple. Compresses of cold solutions of boric acid were placed on the eyelids and atropine was instilled into the left conjunctival *cul-de-sac* four times a day. One week later the cold compresses were discontinued.

In two months' time the absorption of the hemorrhages was

complete and with a convex spherical lens of one and a quarter diopters' strength visual acuity was increased to five-sixths of normal. There were defects in the corresponding visual field.

In other cases sight may be immediately and permanently abolished, the eye becoming disorganized by a detachment of the vitreous humor and retina from profuse hemorrhage.<sup>59</sup>

The detached and lacerated retina may become inflamed, followed later by a cicatricial contraction of the retinal tissues, which will seriously compromise vision. It is consequently imperative to observe such cases for prolonged periods of time before an opinion as to prognosis can be given.

#### (B) RUPTURES OF THE CHOROID.

As the result of a contusion or a direct compression of the eyeball or as the consequence of a shock that has been imparted to the orbital or the periorbital bones by a blunt body, the choroid, together with the external layers of the retina, may become ruptured and torn in one or more places, the other ocular coats remaining uninjured (*so-called isolated ruptures of the choroid*<sup>60</sup>). In the great majority of such cases, this solution of continuity of the choroidal tissues, which is usually single, is situated between the optic disk and the macula lutea. On account, in part, of the marked extensibility of the choroidal membrane in the equatorial portion of the eyeball, the break is rarely seen in this position. At times it has been found in the anterior portion of the membrane near the ora serrata and the ciliary region. Cases of double, triple, and even quadruple rupture have been seen and reported by Teillais, Fage, and others.

When the blood that is extravasated into the anterior chamber or that is infiltrated into the vitreous humor does not prevent an ophthalmoscopic examination of the eye-ground the cleanly-cut rupture may be plainly seen at the time of its production. Later a cicatrix in the region of the macula lutea will be found exhibiting its characteristic form of a pearly-white, curved streak that is bounded by a pigmented border and which is surrounded by an irregular pigment-area. In front of this the vessels of the retina, unless they have been divided at the time of the accident, will be found to pass intact.

The prognosis of choroidal ruptures depends upon the intensity of the wounding force, upon the character and the degree of the lesions that have been produced in other parts of the eye (hemorrhages into the vitreous humor, detachments of the retina, etc.), and upon subsequent complications, such as iritis, retinitis, etc.<sup>81</sup>

Multiple ruptures, which are the result of violent contusions, are generally accompanied by rupture of the sclera. These usually terminate in the loss of the eye.

When the rupture is simple, it ordinarily merely gives rise to disturbances during attempts that are made for direct vision, and tends to produce scotomata that vary considerably in direct accordance with the seat and the extent of the rupture itself.

At first vision is so profoundly altered that the patient in many instances is not able to see to count fingers even at a short distance in front of the eye. This is particularly so if there has been an intraocular hemorrhage. Sight, however, often becomes rapidly better at the end of several weeks' time. At times there is a return to almost normal visual acuity, but such cases are rare; so that too much caution cannot be exercised in any medico-

legal report as to the certainty of restitution of vision or even its preservation after such a form of injury.

Sometimes any central or peripheral form of scotomata that may have been due to a compression of the retinal elements by bloody effusion may become manifest to its maximum extent and density immediately after the accident; but with the return of direct visual acuity such breaks and gaps in the field of vision may gradually disappear as the sanguineous effusion is absorbed.

The persistence of amblyopia and of scotomata indicates in many such cases that the retina has been involved at the same time as the choroid. The ophthalmoscope will, moreover, reveal the alterations that have been undergone by the retina,—this complication only too often terminating in a monocular form of blindness which ordinarily follows atrophy of the optic nerve and retina.



## CHAPTER V.

### RETINA.

ON account of its situation, the retina is seldom, if ever, injured alone. In the study which has been made of penetrating wounds of the eyeball it has been shown that slight solutions of continuity of the choroid and the retina, which are produced by aseptic pointed and cutting instruments, heal promptly and produce functional disturbances of merely relative importance. In such cases, particularly after a wound of the retina, there remains but a pigmented cicatrix, which adheres to the choroid.

As a rule, traumatic lesions of the retina are due to contusion of the eyeball, which is either direct or is produced by *contrecoup*, or are dependent upon penetration of a foreign body. The list of the most common types of injuries comprise shock, hemorrhage, rupture, detachment, and the presence of foreign bodies.

#### (A) SHOCK, RUPTURE, HEMORRHAGE, AND TRAUMATIC DETACHMENT.

Berlin,<sup>62</sup> who has studied shock of the retina, both clinically and experimentally, has noted the occurrence of the following symptoms at the time of the accident: Localized pericorneal injection, pain in the ciliary region, marked photophobia, great resistance of the iris to the action of atropine, and decrease of central vision without any appreciable contraction of the visual field.<sup>63</sup> With the ophthalmoscope he sometimes found, particularly in the vicinity of the macula lutea and the optic disk, and

at times in other places, according to the location of the traumatism, edematous and grayish nebulous foci in front of which the retinal vessels passed intact. The optic disk itself was generally hyperemic. He noticed that these cloudy disturbances gradually decreased, disappearing about the third day.

Berlin also demonstrated that experimental contusions produced similar lesions, and determined the presence of bloody effusions that were situated between the ciliary muscle and the sclera, the sclera and the choroid, and the choroid and the retina.

The visual disturbances which this author has described as being due to irregular astigmatism following deformity of the crystalline lens from compression by hemorrhagic foci in the ciliary region, and which other authors ascribe to disturbance of accommodation are, however, just as transient as the retinal halo itself. Nevertheless, as de Wecker has shown, atrophy of the retina and of the optic nerve (probably from injury to the retrobulbar portion of the optic nerve) has been seen to develop after a contusion of the eyeball in which no appreciable lesion of the fundus of the eye could be detected.

Temporary subnormal color-perception and amblyopia without lesion discoverable with the ophthalmoscope have likewise followed injuries to the head, and have been recognized after so-called simple shock to the eyeball (Wilson and Tyndall, Favre). Before attributing either of these conditions to any definite variety of traumatic anesthesia which is supposed to have been caused by "molecular shock of the retina," the medical expert must determine that he is not dealing with a case of toxic or hystero-traumatic amblyopia or with disturbances due to paralysis or spasm of the ciliary muscle, etc.

The functional or subjective symptoms that traumatic hemorrhages of the retina produce are dependent mainly upon the position and the amount of the sanguineous extravasation. The slightest blood-area or even the finest punctate hemorrhage in the immediate vicinity of the macula lutea may cover extraneous objects with red- or even green- colored clouds. In some cases there may be such conditions as metamorphopsia or momentary losses of central vision. Peripheral hemorrhages give rise to eccentrically-placed scotomata. Blood-extravasations in the neighborhood of the ora serrata do not produce any troublesome visual disturbances, and, as a rule, are only recognized subjectively with the ophthalmoscope.

Most of the traumatic forms of retinal hemorrhages recover without any appreciable alteration in visual acuity. An exception should be noted in cases of hemorrhages in the macular region and in those in which, on account of their size and extent, absorption is so slow as to allow either fatty degeneration of the retinal tissue or the formation of localized pigment-spots to take place (Hersing, Delacroix,<sup>64</sup> Berlin,<sup>65</sup> and Poncet<sup>66</sup>). More recently de Lapersonne and Vassaux<sup>67</sup> have described a pigmentary form of infiltration of the retina following certain types of traumatism of the eye which is similar to that seen in pigmentary retinitis, especially in cases of injuries to the optic nerve and to the neighboring vessels.

Large effusions sometimes detach the retina or else tear it and thus invade the vitreous chamber, giving rise at times to a pigmented form of connective-tissue material which becomes fibrous, producing—upon contracting—complete atrophy of the retina.

In consequence of direct contusion of the eyeball (usually the result of the impact of a blunt body of small

size) the retina may present a series of isolated ruptures situated toward the posterior pole of the eye, and which the ophthalmoscope makes evident under the form of chalk-white cicatrices bordered with pigment. If the tears have been complete, the retinal vessels disappear at the position of the cicatrices; if the solutions of continuity have involved only the external layers of the retina, they pass over the tear intact.

Immediately following such an accident the patient usually complains of a considerable degree of diminution of visual acuity, and is apt to note the presence of varying types of scotomata. These functional forms of visual disturbance may become better for a time as the extravasation is absorbed; but later cicatricial contraction produces destruction of the perceptive elements of the retina, giving rise to almost complete abolition of sight. Prognosis, therefore, in most cases is very unfavorable.

Traumatic detachment of the retina—that is, separation of the retina from the choroid—is produced in different ways. It has been seen, in connection with the subject of injuries of the sclera, that penetrating wounds of the eyeball and foreign bodies in the eye may produce bloody effusions between the two internal envelopes of the eye. The lesion may also be the immediate consequence of extensive loss of vitreous humor, or later of cicatricial contraction existing between the vitreous body and the wound itself. At times the retinal detachment is hemorrhagic in nature, the result of a contusion of the globe by a blow from a fist, a fragment of wood, a stone, etc.

The functional symptoms seen in these cases vary, being in direct relation with the seat and the extent of the detachment, as well as being dependent upon the presence of lesions of the choroid and other parts of the eye.

In most cases the patient complains of an immediate disturbance of vision. He will assert that he is barely able to distinguish gross objects, such as the upheld fingers, and only at a short distance in front of the eye. If the macular region be invaded, central vision is oftentimes practically abolished; whereas, on the other hand, sight will only be decreased in proportionate degree if the detachment is peripheral. The visual field will present contractions and blind areas corresponding precisely with the portions of the retina that are detached. In most cases objects will appear more or less distorted (metamorphopsia).

Traumatic detachment of the retina is not so serious as are the other varieties of retinal detachment. Indeed, there are instances of complete recovery in cases of this type of disorders. (Von Graefe, Galezowski, Armaignac.<sup>68</sup>)

Prognosis is in direct relation with the position and the extent of the lesion, though ordinarily the traumatic form of the affection has a tendency to improve by absorption of the effusion.

(B) FOREIGN BODIES IN THE RETINA AND  
IN THE CHOROID.<sup>69</sup>

When propelled by a sufficient force, grains of lead, sharp metallic particles, pieces of percussion-caps, fragments of stone, etc., pass, as a rule, through the corneal membrane, the iris, and the crystalline lens. If they enter the eyeball through the sclera, they may lodge either in the crystalline lens or pass directly into the vitreous humor; or they may become fixed in the choroid, the retina, or the optic nerve-head. On account of the comparative thinness of the two intimately-associated membranes (the retina and the choroid) foreign bodies are usually imbedded in them at the same time, sometimes penetrating into the scleral

covering. In consequence, it is best to consider the affections of the two coats at the same time.

Out of seventy cases of foreign bodies situated in the posterior hemisphere of the eyeball, Coppez (*loco citato*) found but two in which the choroid and the retina were involved. They are, therefore, in accordance with his experience, relatively rare.

If the foreign body is small in size, and if it is smooth, aseptic, and but slightly or not at all oxidizable, it may become encysted and remain harmless in the two membranes after having produced a slight inflammatory reaction. Careful perimetric examination in such cases often reveals the presence of interruptions in the visual field corresponding with those that are seen in cases of the circumscribed foci of retino-choroidal inflammation, or detachment. Central vision in many such cases may remain intact. Hirschberg, Mengin, Landesberg, Knapp, Hosch, de Gonzenbach, Roy, and others have published cases of this kind.<sup>70</sup> Some years ago the author had under his care a patient—a weigher at a mint—whose left eye had been injured by a chip of steel, the offending particle being lodged in the retina. Recovery with normal visual acuity took place and has remained to this day.

CASE XII (personal and unpublished).—Foreign body in the retina. Encystment. Recovery with normal vision.

On the thirteenth of December, 188-, B. T., a 32-year-old weigher, was struck in the left eye by a piece of steel. There was no apparent reaction, except a small subconjunctival ecchymosis which was situated near the inner canthus. The patient complained of a sensation of slight heaviness in the eyeball, but the globe was not painful on pressure. Visual acuity equaled four-fifths of normal.

The piece of steel had struck the eye at the inner corneal limbus, producing a wound barely half a millimeter long. Near

the periphery of the iris, directly opposite the corneal wound, there was a minute oval opening. The pupil was the same size as its fellow, and there was not any hemorrhage into the anterior chamber.

Ophthalmoscopic examination showed that the crystalline lens and the vitreous humor were transparent. A fragment of metal could be plainly seen in the forward part of the retina to the inner side. Surrounding the foreign body was a narrow zone of edema.

The patient was urged to consent to extraction of the foreign mass as a means to protect his eye from immediate or subsequent danger. He refused to permit any operative intervention.

The eye was treated by the employment of constant applications of boric-acid compresses and the use of instillations of atropine four times daily.

During the next few days the eye became slightly injected, the pupil slowly dilated, and the retinal edema increased. The vitreous humor and the crystalline lens, however, remained transparent. Central vision continued normal; but the visual field was contracted on the outer side.

In nearly four weeks' time the foreign body was hidden by a grayish-white exudate that was the size of the head of a large pin.

Three weeks later the patient resumed his work. At this time his visual acuity had become normal, though the outer part of the visual field still remained contracted. Seven years after the accident the patient consulted the author for the treatment of a superficial burn of the cornea, at which time it was found that excellent visual acuity with the eye still remained.

In the majority of cases the prognosis is not favorable, encystment with preservation of good visual acuity being a rare exception.

The seriousness of prognosis in such cases, however, depends largely upon the situation of the wound and upon the character of the tissues that have been injured. For example, the results of the passage of a foreign body through the sclera in the equatorial region of the eyeball gives rise to much less serious consequences than if the

mass had passed through the iris, the crystalline lens, the vitreous humor, or the ciliary body.

Moreover, encystment of the mass itself tends to protect the eye from all subsequent danger. The inflammatory exudate enveloping the foreign body in the choroidal membrane may, however, frequently become infiltrated with lime-salts, and thus prove a source of irritation; or, as the result of a subsequent traumatism, the mass may rupture and the foreign body be set free, thus giving rise to more or less serious complications.

The contraction of the connective tissue surrounding the foreign material may lead to secondary detachment of the retina.

Usually, penetrating substances are infected and produce violent inflammation, which rapidly destroys the eye. In other cases inflammatory reaction, though less intense and more limited, may lead to atrophy of the organ.

Kostenitsch's examinations of twenty human eyeballs that had been enucleated on account of penetrating wounds caused by pieces of percussion-caps have confirmed the results of the experiments that have been made by Leber on the effects of the influence of metallic foreign bodies upon the eyes of rabbits. Copper, by its chemical action, produces suppuration without the intervention of micro-organisms. This is more marked when the metal comes into contact with the muscular parts of the eye, while inflammatory reaction reaches its height when the metallic chip becomes fixed in the retina in the vicinity of the optic disk or in the ciliary body.<sup>71</sup> In a discussion on Leber's communication upon "Injuries of the Eye Caused by Pieces of Copper,"<sup>72</sup> Kipp and Meyer reported cases of preservation of the eye with good visual acuity after the penetration of fragments of gun-caps into the retinal tissues.



In cases in which the injured eye preserves a certain degree of vision the visual field presents scotomata that correspond either with localized retinal detachments from chorio-retinal hemorrhages or from areas of circumscribed chorioretinitis. It must not be forgotten that detachment of the retina is not always an immediate result, it appearing gradually in some cases and reaching such a degree, at times, as to produce blindness.

To summarize: the presence of foreign bodies in the choroid and the retina presents a most unfavorable prognosis from the stand-point of the conservation of the visual function of the injured eye. Moreover, the foreign materials frequently serve as the starting-points for the condition known as sympathetic ophthalmia.

## CHAPTER VI.

### CRYSTALLINE LENS.<sup>73</sup>

THE manifestations of traumatism of the crystalline lens are classified under three heads: (A) traumatic luxations [and subluxations]; (B) traumatic cataract; (C) foreign bodies in the crystalline lens.

#### (A) TRAUMATIC LUXATIONS AND SUBLUXATIONS.<sup>74</sup>

The crystalline lens is displaced generally as the result of concussion from a violent shock sustained by the skull or the body, or by the stroke of a whip, or as the result of a wound which involves the zonule of Zinn. The position assumed by the crystalline lens differs in accordance with the direction that has been taken by the offending object. The degree of violence of the traumatism to which the structures of the organ has been subjected and the previous presence of pathological conditions such as are found in high myopia, anterior staphylomata, etc., also become important factors in the question. Congenital ectopia and a fluid condition of the vitreous body are additional predisposing causes.

The crystalline lens may be tilted and undergo vertical or a lateral displacement, remaining, in part, lodged in the hyaloid fossa (subluxations<sup>75</sup>), luxated either into the anterior chamber or into the vitreous humor, or, as has been seen while studying traumatic lesions of the sclera, it may be forced into the subconjunctival cellular tissue<sup>76</sup> and even expelled from the eye.

Inclination and lateral displacement of the crystalline lens give rise to characteristic objective symptoms, namely: inequality of the depth of the anterior chamber and tremor of the iris, with certain ophthalmoscopic signs. Not less distinct are the visual disturbances. Subluxations, according to their variety and their degree of displacement, are followed by a loss of the power of accommodation, by a certain degree of irregular myopic astigmatism, and, in the cases of marked deviation, by the phenomena of monocular diplopia and polyopia. Finally, luxations may become complete and the crystalline lens assume a cataractous condition.

A subluxation may, moreover, be the starting-point for the condition known as chronic glaucoma, with or without obliteration of the angle of filtration: a lesion of which, to-day, there is a tendency to consider, by some, not as primary, but as secondary to the glaucomatic<sup>77</sup> process.

In a general way, except in cases in which traumatism restores vision by displacing a crystalline lens that is cataractous, even partial luxations of the lens always disturb vision, especially for near-work. After complete rupture of its suspensory apparatus the lens either passes forward into the anterior chamber, between the iris and the cornea, or is forced backward into the vitreous body. In some cases it remains engaged in the pupillary orifice and may give rise to glaucomatous symptoms.

If the capsule of the crystalline lens is ruptured, the lens itself may become rapidly opaque and the symptoms of glaucoma appear at once. If the capsule is uninjured, it may temporarily remain relatively harmless and transparent in the aqueous humor. In the course of time, however, it, as a rule, becomes adherent to either the iris or the

cornea, and, as one of the results, produces an ulcerative form of keratitis or a chronic glaucomatous iridocyclitis; so that, in the great majority of such cases, operation becomes necessary. As a rule, extraction of the cataractous lens is not particularly easy. The procedure necessitates the employment of chloroform or ether narcosis and favorable results cannot always be secured on account of the presence of other lesions of the eye and of the loss of vitreous humor at the time of the operation.

Dislocation of the crystalline lens into the vitreous humor is more frequent and is less serious. As in the preceding types, if the capsule is intact it may not cause any reaction for years; the unused eye acts just as in the case of aphakia. At other times, on account of its great mobility, the diseased lens may become the primary cause of chronic iridocyclitis, of glaucoma, or of sympathetic complications.

#### (B) TRAUMATIC CATARACT.<sup>78</sup>

According to some statistics, traumatic cataract is found from three to five times in one thousand cases of diseases of the eye. Experiments by Berlin, Schirmer, Stein, and others, as well as clinical observations, show that so-called simple shock of the crystalline lens may produce an opacity which is either partial or complete, and that such an opacity may be transient or permanent.<sup>79</sup> Typical traumatic cataract usually results from the direct action of pointed, cutting, or blunt instruments, or by the presence of a foreign body, which, after penetrating the coverings of the eye, injures the lenticular capsule and the lens-fibres themselves. Sometimes the crystalline lens is displaced by rupture of the zonule of Zinn.

Most prominent in the list of wounding agents stand metallic chips, lead shot, points of scissors, needles, knives, and pens. This is followed by contusions of the eyeball, caused by blows from fists, rubber balls, and corks. Severe shocks to the skull or to the skeleton may indirectly produce lacerations of the anterior or the posterior lenticular capsule, with frequent rupture of the suspensory ligament of the lens.

From a medico-legal stand-point it is important to remember that by some it is stated that an opacity of the crystalline lens may not appear until a long period of time after an accident<sup>80</sup>; so that unilateral cataracts which are apparently idiopathic in type may, in reality, often be due to the penetration of some foreign body, or may be secondary to deeper forms of lesion of the eyeball, such as choroidal rupture and detachment of the retina. Becker and others have for a long time drawn attention to this point.

In all cases the iris should be examined carefully in order to determine whether there is any minute break in its tissue or any loss of substance, as these conditions frequently indicate the direction of the track of a wounding agent. "Beware of traumatic cataracts," said Trélat; "they accompany traumatisms in all of their varieties, and are frequently associated with all their consequences." "It is the half-successes and the failures," he asserts, "which make up the balance-sheets of the operative treatment of traumatic cataract."<sup>81</sup> He believes that "as a general statement, every injury to the crystalline lens should be considered as a serious menace for the existence of an eye."<sup>82</sup>

Traumatic cataracts are often complicated; but the complications seen in such cases vary with each particular instance. In fact, no affection demands of the surgeon

more caution in prognosis nor more competency and patience in treatment. They may be divided into partial or total, and can be subdivided into simple and complicated.

Cataracts caused by shock or contusion, without perforation of the membranes of the eye and without concomitant lesions of the deeper parts of the organ, often recover without any complication and with satisfactory visual acuity. Such cases are rarely infected. A small foreign body or a sharp-pointed aseptic instrument will make a minute opening in the lenticular capsule, and may produce an opacity of the lens, the absorption of which will be the more rapid and the more complete, the younger the patient. If the capsular wound is quite narrow, however, and especially if it is in contact with the iris, the return of the transparency of the lens will be often prevented by a too early cicatrization, so that as a result a partial capsulo-lenticular opacity which will diminish direct vision, unless the injury is in the equatorial region, may be formed.

Haltenhoff,<sup>83</sup> in his report upon the "Treatment of Traumatic Cataract," cites the case of a mechanic whose crystalline lens became cataractous in consequence of the penetration of a chip of metal, the patient returning to his work with a normal visual acuity at the end of a month's time.

On account of the retraction and a curving of the edges of the capsular wound an extensive laceration of the capsule of the crystalline lens may produce, as a rule, a complete lenticular opacity. This is generally followed by an absorption of the cataract. The process, which is rapid and nearly always complete in childhood and in youth, is usually slow and incomplete in the adult and in the aged subject. Absorption may begin many months after an accident, and thus cause a disappearance of the opacities

that have been stationary until that period of time. Rare cases have been reported in which such cataracts have been absorbed at an advanced age. One case in a patient fifty-eight years old was seen by Haltenhoff and another by Steffan in a sixty-nine-year-old subject. De Wecker considers infection a most important factor in the development of such types of cataract.

Moreover, an eye which has recovered a fair degree of visual acuity after the removal of such a cataract can generally be employed only to increase the extent of the visual field. It cannot be used for near-work, unless the fellow-eye has a lower grade of vision.

Infection is to be feared the most when the ocular tissues have been contused or extensively lacerated, and thus becomes a serious complication of the traumatic form of cataract. A simple prick of an infectious character, for example, may be followed by a keratitis and an iritis with hypopyon.

Iritis is a most common condition. According to Pruet (*loco citato*), it is found in 66 per cent. of all cases. It frequently develops into a chronic form of iridocyclitis. Chemosis, palpebral edema, and purulent infiltration of the cornea indicate a deeper type of inflammation and bespeak the beginning of a panophthalmitis. If such a condition occurs an early enucleation or evisceration, when possible, should be performed in order to protect the fellow-eye from sympathetic disease and to allow the patient to return earlier to his work. If the surgeon has been sufficiently fortunate to check suppuration, a long period of time should be allowed to elapse before any attempt toward operative measures for the improvement of vision is made. In addition there must be a certainty that the inflammatory processes have subsided. Intraocular tension must be nor-

mal (de Lapersonne<sup>84</sup>), and perception of light throughout the ordinary visual field area must be good.

Too often, indeed, a too-early operative intervention provokes an insidious type of iridocyclitis, which will obstruct the pupil, and even permanently abolish the function of vision.

Traumatic cataract may be also complicated by many non-infectious conditions, among which are glaucoma, luxation of the lens, the presence of foreign bodies, and injuries to other parts of the eye,—the consequences of which in themselves are most variable. When, for example, a large opening of the lenticular capsule of an adult patient gives easy access to the aqueous humor, the crystalline lens often swells considerably during the first few days and gives rise to symptoms of secondary glaucoma. Such glaucomatous signs are favored by the non-elasticity of the ocular membranes in patients of advanced age, by the improper use of atropine, and by displacement of the crystalline lens, particularly in cases in which the lenticular equator irritates the ciliary region.

Later the adhesion of the capsule of the lens to the cicatrix of the corneal wound is an additional cause of increased tension. The discussion which took place at the 1894 Congress of the French Ophthalmological Society has shown, however, that this type of glaucoma need not be particularly feared, and that, if infection or deep anatomical disorders do not produce too great disturbance, subsequent operative procedure adapted to each individual case may give rise to relatively useful results.

The final effects of such operations, however, are far from always being as encouraging as the statistics of Coppez,<sup>85</sup> for example, would lead one to hope, in which, out of 45 cases treated by aspiration, there were 42 suc-



cesses, with visual acuities varying from one-fourth to one-third of normal. Gayet, on the contrary, out of 12 operations for simple traumatic cataract obtained the following results: In 1 case vision equaled one-half; in 2 instances it was one-fifth; in 4 cases it was one-tenth; in 2 it was less than one-tenth; and in 3 it was merely quantitative.<sup>86</sup>

Conclusions: The course and the prognosis of a traumatic cataract differ markedly in accordance with the septic or the aseptic condition of the wounding agent, the amount of injury that has been done to the crystalline lens, to the age of the patient, and to the condition of the other parts of the eye.

The most serious cases are those which result from contused wounds of the anterior segment of the eyeball, the cataract in such instances frequently constituting only an accessory and a secondary form of lesion.

In very young subjects spontaneous and complete absorption of a simple traumatic cataract is not uncommon; and, if the pupillary area has been freed by a retraction of the capsule, the patient is, from the stand-point of vision, in a similar condition to one who has been operated upon for simple senile cataract. Likewise, a partial opacity of the crystalline lens has an opportunity of disappearing; and, if the opacity is located peripherally, it offers, as a rule, but a slight hinderance to the visual function.

If the patient has passed the age of adolescence, absorption will be less complete and not so rapid, and if, as is so frequent, the injury to the lens is complicated by an inflammation of the iris, posterior synechia—with more or less extensive and dense capsular deposits—may be produced, the consequences of these conditions being most unfavorable for the re-establishment of useful vision.

(C) FOREIGN BODIES IN THE CRYSTALLINE LENS.<sup>87</sup>

Since the etiology of foreign bodies in the crystalline lens is about the same as that of foreign bodies in the iris, it seems unnecessary to repeat *in extenso* what has been said before on the subject.

The facts furnished by the patient will oftentimes help to make a diagnosis that is sufficiently accurate to determine, in measure, the consequences of such lesions and to permit the institution of the most appropriate and effective forms of treatment. In general, however, too great importance must not be attributed to the statements of patients, because they are frequently unintentionally erroneous in character. It is better to depend upon a direct and a careful examination. Differential diagnosis is far from always easy. The presence of a foreign body in the crystalline lens can often be determined by means of oblique illumination. If the foreign material is small and if it be superficially located, it will usually remain visible as long as the lens-tissue itself preserves a definite degree of transparency. Such was the case in one of the author's patients, in whose right lens a particle of steel was fixed, the chip of metal being quite easily seen for six weeks' time after the date of traumatism.

The presence of a small wound of the cornea and iris with an opacity of the crystalline lens, following an accident to the eye, is presumptive evidence. The discovery of a foreign body, however, is sometimes rendered quite difficult by its peripheral situation and by the existence of posterior synechia which prevent the dilatation of the pupil, thus not allowing a thorough examination of the lens itself possible. In addition, a previous or an advanced opacity in the lens may conceal the foreign substance.

At times, a yellowish-ochre-like tint, with a point of maximum intensity in some portion of a traumatic cataract corresponding with a cicatrix in the cornea, is a sign of the probable presence of an oxidizable metallic chip (O. Becker, Samelsohn, Ausin). Quite frequently the foreign body does not become apparent until after an absorption of a part of the cataract. It may also happen that the foreign material has passed through the crystalline lens and has become lodged in the vitreous humor. In some cases the maintenance of a full field of good perception of light indicates that the foreign body is probably neither in the vitreous humor nor in the retina and posterior portion of the choroid.

Finally, it is not uncommon for a small foreign body to glance from the anterior surface of the crystalline lens, after having injured it, and to fall into the anterior chamber, from which position the surgeon should extract it as quickly as possible. (Stellwag von Carion.)

The ordinary result of the penetration of a foreign body into the crystalline lens is the formation of a partial or a total cataract. This opacification, as a rule, will be the more rapid and the more extensive the greater is the laceration of the lens-capsule and the deeper is the penetration of the foreign body into the lenticular substance.

A small, pointed, and aseptic foreign body introduced into the superficial and the peripheral layers of the crystalline lens may remain harmless for years, having produced but a limited area of opacity, with a slight diminution in visual acuity. To the cases of Desmarres, Galezowski, Snell, de Wecker, and others, the author takes the opportunity to add the following:—

CASE XIII (personal and unpublished).—Foreign body (steel chip) in the right crystalline lens. Recovery with normal vision.

J. G., 18 years old, an apprenticed mechanic, believed that he had gotten a piece of steel into his right eye while he was engraving. As he had no acute pain, and as his eye was not inflamed, he continued his work for fifteen days, until May 28, 1886. At that time he consulted the author on account of a blurring of vision in the right eye that had annoyed him for a period of several days.

Examination of the right eye showed, with oblique illumination, a corneal cicatrix which was barely one millimeter in length. The scar was situated in the inferior nasal portion of the membrane. Directly back of this the pupillary edge of the iris presented a minute nick in its tissue, at which point there was an adhesion to the anterior capsule of the crystalline lens. The lens itself appeared somewhat clouded. At this visit the patient was able to see to count fingers at one meter's distance.

After the instillation of several drops of a solution of atropine a black body, about the size of a pin's head, could be seen located on the anterior surface of the upper third of the crystalline lens. From this point opaque striae radiated in all directions.

The opacification extended slowly in the cortical layers of the lens for about a month's period of time, while vision became increasingly disturbed. The eyeball itself did not present any signs of gross inflammatory reaction.

On the seventh of July the patient was again seen. It was then found that only a slight and superficial opacity could be determined near the chipping of steel. With a convex spherical lens of  $1\frac{1}{4}$  diopters' strength visual acuity with the affected eye equaled five-sixths of normal.

Four years later the patient returned for the treatment of a burn of the left upper eyelid. At this visit it was determined that the vision of the affected organ was fully preserved.

It must be remembered that the composition of the foreign body is of the greatest importance. Splinters of glass are well tolerated, while chips of copper and bits of percussion-caps, for example, produce marked inflammatory symptoms. This innocuousness of some forms of foreign bodies, however, may be but temporary, and the materials may give rise, after varying lapses of time, to in-

flammatory reaction. To the dangers already mentioned as the result of this condition must be added those which come from the formation of areas of degeneration in the crystalline lens and from the immediate or subsequent escape of a foreign body into the anterior or posterior chamber. Should the latter occur, repeated attacks of iritis and iridochoriocyclitis may be produced, which will be frequently followed by loss of the eye and at times lead to sympathetic disease.

Prognosis in such cases, therefore, is unfavorable, the conditions frequently, if incapsulation does not take place, remaining threatening until the cataractous lens and the foreign bodies have been extracted. This operation, however, which is quite a delicate one, is not free from danger, the results, moreover, not always being satisfactory; hence the medical expert should not formulate a definite opinion upon the final outcome of such an accident until after an adequate and extended observation of the patient has been made.

Direct extraction of fragments of steel and of iron that have become fixed in the cortical layers of the crystalline lens is greatly facilitated by the use of magnetic instruments, or of the electro-magnet, such as those of Hirschberg, McHardy, and Haab. As soon as possible after the accident, an ordinary electro-magnet or a magnetic lance (Hirschberg) should be introduced into the lens either through the wound of entrance of the foreign body or through an incision especially made for the purpose. Some operators prefer to extract small, superficially located particles by means of a pair of curetting forceps.

## CHAPTER VII.

### VITREOUS HUMOR.<sup>88</sup>

THE lesions here comprise: (*A*) wounds; (*B*) foreign bodies in the vitreous humor.

#### (A) WOUNDS OF THE VITREOUS HUMOR.

Injuries to the vitreous humor have already been incidentally discussed in connection with penetrating wounds of the sclera. It has been there seen that the results of this variety of traumatism have their maximum importance when there is an associated lesion of the ciliary body, considerable loss of the vitreous humor, abundant intraocular hemorrhage, and deep penetration of a septic foreign body. In the last condition there is generally a rapid development of a suppurative form of hyalitis, while the contents of the vitreous chamber are converted into an abscess-mass.

Although it is not immediately serious, traumatic inflammation of the vitreous humor of plastic type (plastic hyalitis) following penetrating wounds caused by pointed and cutting instruments, whether complicated or not, produces, as a rule, irremediable disturbances of the visual functions. Indeed, it is well known that the form of localized chronic hyalitis which is caused by small pointed instruments (needles, bodkins, etc.) generally terminates in the formation of connective-tissue bands which slowly invade the entire vitreous chamber. Gradual contraction of this newly-formed tissue ensues, while the retina, the vitreous humor, and the choroid become detached and the eyeball atrophies without the appearance of any marked

questioned as to the circumstances under which the accident occurred and should be asked to describe the form, the nature, and the probable course of the projectile. The situation, the character, and the direction of the corneal or the scleral wound, the nature of the injury to the crystalline lens itself, the rapidity of the loss of sight, and the occurrence of bubbles of air in the vitreous chamber (Hirschberg and Hildebrand) are all important conditions which make a diagnosis probable, but not certain. In some cases a foreign body may pass through the eyeball and escape either into the orbital cavity or go still farther back.

In cases in which the presence of metallic particles of iron or of steel are suspected the diagnosis can be made much more certain by the employment of a so-called magnetic needle. Various forms of rotating apparatus which will permit the locality of an iron or steel fragment by angular deviation of a needle or some other form of indication to be determined have been devised for this purpose (Pooley, Pagenstecher, Asmus, etc.<sup>91</sup>). Coppez and Gallemaerts have shown that the magnetometer of Gerard can be usefully employed for this purpose, they having found that it indicates the presence in the eye of a magnetic form of foreign body of even one-half a milligramme weight, and that it serves to give useful information as to the position of the mass.<sup>92</sup>

In a general way, the prognosis in such cases is quite serious, this being true in spite of the recent improvements in operative interference and technique (Hirschberg, Mayweg, Hildebrand,<sup>93</sup> and Haab). Such cases are particularly desperate when a foreign body is contaminated, it being very apt to rapidly produce a general suppuration of the eyeball. This is particularly true when there is pronounced intraocular hemorrhage, when the escape of vit-

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reous humor has been abundant, and when the iris, and, especially, the crystalline lens have been injured. The lens-tissue itself is a particularly favorable soil for the culture of infectious germs. In this connection de Wecker has pertinently remarked that the surgical dressings in such cases are often much more dangerous than the presence of aseptic foreign bodies themselves.

Very rarely a smooth, aseptic, and non-oxidizable body may be definitely tolerated. Generally, however, after a more or less prolonged period of quietness, its presence, or, more frequently, its displacement, becomes the starting-point for an attack of iritis or a chronic plastic form of hyalitis, which is followed by a detachment of the retina and by a shrinkage of the vitreous humor. These types of lesions ordinarily terminate in the destruction of the organ or may produce sympathetic disease and even disturbances in the general health. It is true, nevertheless, that a certain number of cases of encystment of foreign bodies with preservation of good vision have been published (von Jaeger, von Graefe, Pflüger,<sup>94</sup> and Hirschberg); but, as Yvert has most properly observed, there has been, as a rule, too much haste in drawing favorable conclusions from such observations.

The experiments of Leber show very well that the reaction of an eye wounded in this manner depends in measure upon the size and upon the chemical nature of the foreign substance, upon its septic or aseptic state, and upon its situation. Non-oxidizable metallic particles, free from infectious germs, do not, as a rule, produce any appreciable inflammation; while almost all authorities have recognized the relative benignity of wounds of the vitreous body and of the deep membranes of the eye by lead shot of small calibre,—which are sterilized in some way, par



ticularly by the explosion of the powder (Rolland, Fornatola<sup>95</sup>). Oxidizable aseptic metals, with the exception of copper<sup>96</sup> and metallic mercury, although producing supuration, serve, nevertheless, as agents for the starting-points of more or less serious lesions in accordance with their positions and their relative size.

As in the great majority of cases the foreign bodies in the vitreous humor are composed of iron or steel, magnetic instruments or electro-magnets<sup>97</sup> are among the useful agents for their removal. In such cases the small, magnetic probe of Collin is of use, as in the following instance:

CASE XIV (personal).—Metallic fragments in the vitreous humor of the right eye. Extraction with the magnet of Collin. Suture of the conjunctival membrane. Recovery.

F. D., a locksmith, 47 years of age, consulted the author on the eleventh of July, 1884, one-half hour after an injury to his right eye by a piece of hot iron. The metallic body had struck the eyeball four millimeters behind the sclero-corneal border, and had produced a wound of the sclerotic of about five millimeters in length, just above the insertion of the internal rectus muscle. There was a slight prolapse of the vitreous humor. The pupil was dilated. Ophthalmoscopic examination showed an elevation of the retina situated in the region corresponding with the wound. This swelling was apparently caused by an effusion and extended into the vicinity of the optic disk. Beneath this area a blackish foreign body could be plainly seen. Vision was reduced to one-thirtieth of normal. The patient complained only of a feeling of weight in the eye.

Under chloroform narcosis, the author carefully probed the wound and discovered a piece of metal at its lower angle near an opening of the sclera. A Collin magnet was introduced into the eyeball through the wound, and, at the first trial, a flat, triangular chip of iron was extracted, this being obtained with but a slight loss of vitreous humor. After thorough irrigation of the wound with a solution of boric acid, the conjunctival break was sutured and cold dressings were applied.

On the third day the suture ———— ved. Compression was

continued until the twenty-fifth day, by which time the scleral wound had healed. At that time visual acuity had risen to two-thirds of normal.

The chances of success in such cases are good when the foreign body is small, when it is so situated that it can be easily reached without producing too much damage to the ocular structures, and when attempts to extract the mass are made immediately after the accident. Removal by means of strong electro-magnets which work at a distance is preferable in many cases to procedures that necessitate the introduction of instruments into the vitreous humor,—as the presence of such contrivances themselves in the ocular tissues exposes the organ, not only to infection, but to inflammatory reaction and degenerative changes. Haab has been successful, by means of a powerful form of instrumentation, in ejecting through the wound of entrance chips of iron and steel that have been located in the vitreous chamber and in the retinal membrane.<sup>98</sup>

This propitiousness of result is not the case if the nature or the position of the foreign body cannot be diagnosed sufficiently early after the date of traumatism. Under such circumstances it is preferable in some cases not to make any operative interference unless the actual existence of the eye is threatened; in others the trial may be worth attempting.

Efforts at extraction have undoubtedly at times been followed by complete success; nevertheless some of the so-termed recoveries cannot be considered as permanent, for the loss of vitreous humor which generally accompanies such an operation with subsequent cicatricial contraction of the wound may ultimately give rise to the loss of an eye that had been considered as saved. As far as the preservation of vision is concerned, the results that

are permanently obtained are far less brilliant than those which have been gotten immediately after the operation. According to the statistics of Snell,<sup>99</sup> Horner,<sup>100</sup> Schiess-Gemuseus,<sup>101</sup> Hirschberg (*loco citato*), and others, resultant vision in such cases has remained satisfactory in about 10 to 15 times out of 100. Hildebrand's figures are somewhat more satisfactory, showing a proportion of 31 recoveries out of 100 cases,—the shape of the eye being preserved in one-half of the number of cases.

## CHAPTER VIII.

### TRAUMATIC LESIONS OF THE EYE AS A WHOLE.

IN order to complete the study which has been made of injuries of the various parts of the visual organ, a few words upon those cases in which the traumatism involves almost the entire eyeball may be advantageously added. Those forms of multiple and complex lesions, of which connected and logical descriptions could not be well given in the preceding chapters, comprise ordinarily: (A) contusions, luxation, and avulsion of the eyeball; (B) wounds and burns of the eyeball.

#### (A) CONTUSION, LUXATION, AND AVULSION OF THE EYEBALL.

It has been known since the discovery of the ophthalmoscope that various functional disorders which were formerly attributed to "commotion" of the globe, *sine materia*, are in reality the results of contusion, and are associated with definite anatomical changes, the gravity of these lesions, in a general way, being proportional to the violence and the character of the traumatism. In determining the extent of the damage that has been produced by a traumatism and what proportion of a lesion is due to the condition of the patient, the medical expert must take into consideration the previous condition of the organ, its degree of prominence, the state of its refraction, and the age of the patient. Thus, in the following case the author's conclusions would have been at variance, if a myopia of very high degree had not existed.

CASE XV (personal and unpublished).—Contusion of a myopic eye. Traumatic detachment of the retina. Medico-legal report.

The author was appointed a medical expert by the first Chamber of the Civil Court of the City of Lille, with instructions to determine "the present condition of V.'s right eye; to decide if this condition is the result alone of the blow inflicted upon it by D., or, if it should be ascribed partly to the blow and partly to individual condition, what might be the results of such conditions, and what consequences might arise in the future."

According to the official documents and to information elicited from both sides of the case, V., during a dispute on the morning of the thirtieth of September, 189-, had been struck violently upon the right eye by D. Several hours after the accident the patient was seen by a physician, who found that "the right eye was blood-shot and the conjunctiva was injected." As the physician did not detect any serious lesions, and did not make an examination of the fundus of the eye, he decided that the patient would be able to return to work in a few days' time.

Dujardin, who was consulted some days later, recognized and certified to the existence of a "detachment of the lower portion of the retina, with probable rupture of the choroid." Subsequent certificates from Dujardin established the fact that, in spite of the medical treatment, the retinal detachment had increased, and the acuity of vision had progressively decreased.

V. was certain that before the date of the blow the vision of his right eye was excellent, and that it had enabled him to perform his work satisfactorily. He had worn a concave spherical lens of five diopeters' strength for a long time. Several hours after the accident he was able with, however, the greatest difficulty, to write a letter, which was dictated to him in the office of his lawyer. Since then his sight has gradually diminished, and at the time of examination he asserted that he could not walk alone with any degree of surety or security, a grayish-white cloud constantly floating before his eyes.

On examination a few "blackish" spots, though quite frequently of a "violet" tint, with balls of fire, abruptly ran across his fields of vision.

The left eye had been rendered useless by a total staphyloma, and had been enucleated about six years previously on account of

severe pain. Since that time, until the thirtieth day of December, he had not consulted an ophthalmologist.

When V. came to the author's office he was led by the hand, and seemed incapable of finding his way alone in a place that was not familiar to him. Careful examination, after correction of his refractive error, showed that central visual acuity was reduced to about one-thirtieth of normal.

There was a marked defect in the upper half of the visual field for both colors and form—in which position he was unable to see to distinguish fingers that were moved close in front of his eye. The cause of this marked decrease in the visual function was sought for by a careful examination of the ocular symptoms, both externally and internally, and the following conditions were discovered: The superior orbital arch projected sufficiently, and the eyeball was not unduly prominent. The lids, the eyebrows, the conjunctiva, and the cornea did not present a trace of recent or of old traumatism. The free edge of the eyelids was the seat of a minor degree of inflammation. The cornea was transparent and the iris appeared normal. The pupil was circular and was moderately dilated. The iris reacted normally under the influence of the usual stimuli. Careful examination of the iris revealed the presence of a slight tremor at its periphery, as if the crystalline lens under the influence of some traumatism had undergone a partial displacement. The tension of the eyeball was rather less than normal. The right eye deviated slightly outward, this strabismus apparently being due to a minor degree of insufficiency of the internal rectus muscles.

Examination of the media by the aid of focal illumination and the ophthalmoscope revealed the presence of several faint stria in the crystalline lens, as well as a slight cloudiness in the vitreous humor. The most important lesion was found located in the retina. This membrane exhibited an extensive detachment in its inferior half, the detached portion assuming the form of an undulating surface with a bluish-gray reflex with which the ordinary color of the fundus of the eye was in marked contrast. The choroid beyond the region of the detachment seemed to be free from any gross alteration. The optic-nerve head was in good condition, but was surrounded by a pronounced staphyloma.

As a result of these findings, the author certified that the detachment of the retina which he described was certainly the

cause of the marked loss of the central and peripheral vision noted above.

As to what would be the results of this affection in the future the author stated that it could not be denied that detachment of the retina is one of the most serious of ocular lesions. The ordinary tendency of such a disease is to be progressive; and, although the condition is at times stationary, complete recovery is very exceptional. He stated that since the various treatments used on V. had not been able to check the course of the disease in the slightest degree, it was to be feared that the amount of vision that was present at the time might in the future undergo still further diminution.

As to the question was the blow that was received the only cause for the ocular condition of the claimant, or should the state of the eye be attributed to the blow as well as to any special circumstances related to the general condition of V., the author asserted that he thought that he could state that the blow given by D. was the direct, the immediate, and the determining cause of the retinal detachment which had affected the eye. Indeed, before the altercation and the blow which followed it V. seemed to have never been troubled with the vision of his right eye, and as he had already lost the left eye, it must be supposed that if any of the functional disturbances had appeared which are so common and pronounced in progressive myopia the claimant would have consulted an ophthalmologist; this he had not done since the operation on the fellow-eye some six years previously. Moreover, he worked at his profession until the day before the dispute, and no one had ever suspected the slightest diminution of his vision. In addition, the examination of the fundus of the eye did not reveal a trace of retinitis, macular choroiditis, tumor, or any gross lesion which might have produced the detachment of the retina. V. had enjoyed good health, his constitution was robust, and a physical examination of his principal organs showed that they were in excellent condition. An analysis of the urine as regards the presence of sugar and albumin was negative.

As to the query could the myopia of about five diopters which had affected V.'s right eye be considered as having some part in the determination and the development of the retinal detachment, the author decided that there was no doubt that a myopic eye is not an absolutely normal one, but cases in which the

disease is stationary must be distinguished from those in which the condition is periodically or constantly progressive. Stationary myopia, of a degree that is less than six diopters, he believed, does not generally present any danger, and does not, as a rule, give rise to any serious lesion of the deep membranes or media of the eye. Progressive myopia, on the other hand, by a series of complications, may lead to loss of vision. V.'s myopia, however, was stationary, and the patient had arrived at an age at which his degree of near-sightedness, except in rare cases, does not increase. Besides, none of the characteristic changes of progressive myopia (extensive staphyloma encroaching upon the macula, areas of choroidal atrophy in the same region, etc.) were visible in his case. Consequently the author considered that the claimant's myopia must be regarded as a very slight factor in the production and the development of the retinal detachment.

As a result of this investigation the following conclusions seemed justifiable:—

"1. The visual acuity of V.'s right eye—less than one-twentieth of normal—and the suppression of a large part of the peripheral portion of the right visual field do not allow the claimant to walk alone with security, still less to continue his occupation.

"2. The present visual acuity, far from becoming better, will in all probability undergo a further diminution.

"3. The present condition of the eye is the result of a traumatic type of detachment of the right retina, due to a blow, received by V. on the thirtieth of September, 189-.

"4. The contused eye had been affected by non-progressive myopia of a degree less than six diopters. This condition could only play a comparative part in the production and the development of the retinal detachment."

Ordinarily a slight contusion of the eye gives rise to only a temporary blurring of vision, which, as a rule, is accompanied by a sensation of dazzling. Generally pain is quite insignificant. When the contusion is somewhat more intense in character, the shock is at times followed by spasm of the iris, paralytic dilatation of the pupil (irido-



plegia), paresis or paralysis of accommodation, and a slight diminution in central and peripheral vision. In general, these symptoms rapidly improve and permanently disappear. However, it is prudent in all cases, even when there is an absence of any appreciable lesions, to be cautious about prognosis, for serious complications may oftentimes appear later (see section on "Shock of the Retina").

A peculiarity that has been long noted, and which the author has been able to see recently verified, in the case of a young college student who was struck in the eye with the point of an elbow, is the persistence of mydriasis, and the resistance of the iris-tissue to the action of eserine. As in the case of the two patients of Armaignac,<sup>102</sup> the amplitude of accommodation in this case remained normal. A case of total separation of the iris, recently seen by René, may be added, to illustrate that the absence of the iris-diaphragm does not sensibly modify the function of accommodation.<sup>103</sup>

With a greater degree of violence given to the eye, such as may be received from heavy blunt bodies, such conditions as hemorrhagic effusion beneath the conjunctiva, into the anterior chamber, and into the vitreous humor may be noticed. Erosions of the corneal membrane followed by local neuralgia, inflammation, and suppuration may also take place, while lacerations of the iris-tissue, of the choroid, and of the retina are not infrequent. Ruptures of the zonule of Zinn and of the capsule of the crystalline lens, followed by luxation and opacification of the lens itself, are not of unusual occurrence. Some of these lesions may be masked for quite a period of time by such conditions as hemorrhages into the anterior chamber or vitreous chamber and opacities in the crystalline lens. It is, therefore, indispensable in all cases to observe the symptoms un-

remittingly for a period of several weeks or months before attempting to formulate any definite opinion upon the gravity and the consequences of any such forms of traumatism.

In cases of violent contusion—such as those which are caused, for example, by large fragments of stone or pieces of iron, or by blows from cows' horns, for example—the eyeball is suddenly compressed, and at times is ruptured, allowing the iris, the crystalline lens, and a portion of the vitreous humor to escape through a large corneoscleral opening. It is unnecessary here to insist upon the gravity of such a condition, which is too often rapidly followed by an intense general inflammation of the eyeball (panophthalmitis), or may terminate in bulbar atrophy after months of conservative treatment. Immediate enucleation is, as a rule, the only resource in such cases.

The prognoses of the different types of traumatic lesions that have been cursorily reviewed are most variable, and have been considered more at length in the preceding chapters on traumatisms of the individual parts of the organ.

The eyeball is sometimes torn from the orbit by the thrust, for example, from a cows' horn, a heavy stick, a foil, or a curved hook. Usually the tips or ends of such wounding agents pass between the bony walls of the orbit and the eyeball, and act as levers, forcibly pushing the eye outward; so that the organ, suspended by the elongated optic nerve, the stretched muscles, vessels, and other tissues, may even protrude far forward. Such a form of displacement is termed true luxation. If the muscles and the optic nerve are torn, the condition is ordinarily known as avulsion.

The most serious complications may accompany these

forms of lesions: rupture of the eyeball, laceration of the eyelids, fracture of the orbital walls, foreign bodies in the orbit, cerebral disturbance, etc. Nevertheless, if the eyeball is uninjured, its reposition by suture of the tendons and conjunctival mucous membrane under antiseptic precautions is, at times, followed by more or less perfect vision and ocular movement. In general, however, prognosis should be most cautious, as the eye may become blind from subsequent attacks of retrobulbar neuritis and consequent atrophy.

In the case of avulsion or complete rupture of the optic nerve it is only necessary to complete the enucleation.

Where workmen have been caught in landslides, in which an eye has been struck by heavy masses of earth or coal (Gesner<sup>104</sup>), or in cases where an eye has been violently contused, as, for example, by the kick of a horse or by a blow from a stone, different authors<sup>105</sup> have observed a sinking of the eyeball into the orbit (enophthalmos), with, at times, a permanent more or less complete loss of vision.

#### (B) WOUNDS AND BURNS OF THE EYEBALL.

Pointed and cutting instruments frequently produce severe injuries of the eyeball. The author has had abundant opportunity of observing many cases of penetrating wounds of the eye that have been caused by knives, weavers' shuttles, and fragments of metal. As the eye in such cases is quite often lost by panophthalmitis or an iridocyclitis, he has frequently advised an immediate enucleation in such cases, by which means he has rid the patients of long periods of suffering, enabling them to return to work much earlier than if the eye had been allowed to remain, and removing almost all danger of sympathetic ophthalmia.<sup>106</sup>

When a foreign body has not penetrated the eyeball, but has produced extensive lacerations, the organ, as a rule, is relatively free from infection and rarely gives rise to sympathetic disease. It must be remembered, however, that large wounds of the cornea or of the sclera may rapidly heal without marked inflammatory reaction, while the organ itself may preserve almost its original normal aspect.<sup>107</sup>

The few exceptionally-favorable cases cannot, however, lessen the gravity of such types of traumatism. Indeed, when a deep and an extensive wound involves the sclero-corneal region, the ciliary body, the choroid, and the retina, there is, as a rule, an evacuation of the crystalline lens and loss of the greater part of the vitreous humor. In such cases irretrievable damage to an eye is almost inevitable. Sympathetic disease is said to be most feared when the wound becomes infected,<sup>108</sup> when the wound is situated close to the ciliary region, and when the general condition of the patient is bad.

Injuries caused by fire-arms and certain types of burns present peculiarities that are worthy of being noted. Wounds by fire-arms are, as a rule, produced by bullets, by shot, and by deflagration of powder. When an eye is struck by a projectile or by a piece of a splintered object, it is generally disorganized and destroyed, unless, as in some instances, the wounding agent passes between it and the bony walls of the orbit.<sup>109</sup> It has been seen that complex lesions—such as section of the muscles and of the optic nerve, enophthalmos—and frequently complications—such as fractures of the orbit and meningo-encephalitis—may be the results of such varieties of traumatism.

Sympathetic disease is, according to most statistics, a frequent complication of injuries of the eye that have been

caused by projectiles. The report of Otis, upon the War of the Rebellion in the United States of America, gives a proportion of about 18 per cent. out of one hundred cases. According to the German documents relating to the Campaign of 1870, more than one-half of the ocular traumas were followed by sympathetic symptoms. In this study, penetrating wounds that were complicated by the presence of foreign bodies gave evidences of this disease in 80 per cent. of the total number of cases, while complete or incomplete loss of the organ of sight occurred in 62.7 per cent.<sup>110</sup>

While Delorme (*loco citato*) doubts that a column of air set in rapid motion by a projectile can produce a shock of the retina, nevertheless observations have proved that an eyeball may be injured by the detonation of projected masses of large calibre. Lègues has recently reported the case of an artilleryman who, while firing a piece of armament of nineteen centimeters' calibre, felt a violent shock and an acute pain in his right eye, the sight in which was immediately lost. Examination showed that there was an extensive hemorrhage in the vitreous humor, while the cornea, the anterior chamber, and the crystalline lens were found to be intact.<sup>111</sup>

The explosion of powder in the vicinity of an eye burns and injures the organ superficially<sup>112</sup> or deeply in accordance with the composition of the material and the position and the distance of the eye from the point of explosion. Powder ignites at quite a high temperature and the burns that are produced are caused both by the gases that are developed and by incandescent grains of carbon. The grains are of a coarser size in mine-powder than they are in gunpowder, and, in consequence, undergo a less complete combustion. Both kinds of powder thus play the

part of true foreign bodies and produce a most marked tattooing; sometimes without inflammatory reaction, but more frequently complicated by minute corneal and palpebral abscesses. At times there may be an obstinate inflammation of the conjunctiva and the cornea, or even of the iris, which may prevent a patient from resuming work for several months' time. The amount of singeing of the eyebrows, and the hair of the head, as well as the presence of whitish zones surrounding the incrustations in a bloodshot and inflamed conjunctiva, often enable the surgeon approximately to determine the distance and the direction of the patient from the point of explosion.<sup>113</sup>

In other cases grains of powder propelled by a greater velocity may pass through the corneal, the scleral, and the iris tissues, and lodge in the crystalline lens, giving rise to a traumatic cataract. They may also act as foreign bodies in the media or the deep membranes of the eye, and become the starting-points of serious inflammatory processes that may end in phthisis bulbi, with blindness. Recovery of such cases has been reported, as, for example, by Oliver<sup>114</sup>; so that this favorable result should not be overlooked.

Multiple traumatic lesions—as, for example, lacerations and wounds of the eyelids, perforation of the ocular membranes, and cataract—that are produced by the gases which are evolved in the deflagration of gunpowder make the results of the immediate type of burns by this agent of secondary importance. Out of seventy-five cases of injuries of this kind, de Bovis (*loco citato*) noted blindness of one eye in twenty-eight instances and of both eyes in three. In an analogous type of case the author succeeded in preserving a satisfactory degree of visual acuity in one eye, though the other one was lost.

CASE XVI (personal and unpublished).— Powder - burns. Penetrating wounds of the left cornea, with hernia of the iris and traumatic cataract. Multiple penetrating wounds of the right eye: enucleation of the right eye. Cataract operation on the left eye: recovery with satisfactory visual acuity.

A. L., a 26-year-old quarryman, was injured on the twenty-seventh of October, 189-, by an explosion of powder while charging a blast. He was under medical advice for about a week's time when he was sent to the author.

At the time of the first examination it was found that there were numerous powder-grain incrustations in the skin of the forehead, the face, and eyelids, especially on the right side. The eyelids, which were reddened and swelled, could only be opened with the greatest difficulty. The patient complained of severe pain in both eyes and in the supraorbital regions.

There was a marked chemosis of the right bulbar conjunctiva. A wound of about four millimeters in length located in the sclero-corneal region could be seen below and to the nasal side of the globe. A smaller wound, involving the cornea alone, was situated several millimeters above the first. The corneal tissue was almost entirely infiltrated with pus.

The lids of the left eye were less edematous than those of the opposite side. The palpebral edges were agglutinated by a slight amount of muco-purulent matter. The conjunctival membrane was moderately injected and was pigmented with carbon-grains, especially in its inferior portion. The lower third of the cornea and the sclera in the corresponding portion were tattooed with grains of burnt powder. At the external portion of the cornea there was a penetrating wound that was about three millimeters in length, between the lips of which the iris was partially prolapsed. There was a traumatic cataract.

On the fourth of November, after a careful examination of the patient, in association with Coppez, the surgeon for an insurance company, it was decided to chloroform the patient and to enucleate the left eye. This was done. The corneal wound healed and the hernia of the iris was reduced. Sixteen days later an iridectomy was done on the right eye, the patient being allowed to return home for about a month's time. On the twenty-seventh of December the cataractous lens was extracted. In two weeks' time

the eye permanently recovered, a convex spherical lens of ten diopters' strength giving a visual acuity that equaled one-half of normal.

Traumatic lesions produced by the explosion of powder, of fire-damp, and of dynamite, or by various chemicals<sup>115</sup> and by electrical discharges can be now considered. This class of injuries, which naturally presents a great variety of lesions, is, as a rule, produced by the projection of small aseptic particles, such as glass, fragments of retorts and receivers, pieces of stone, and *débris* of all kind. Often, owing to the involuntary closure of the eyelids, the burns of the eyeball itself are superficial. So likewise during explosions of boilers<sup>116</sup> and steam-pipes the eyes frequently partly escape the action of the steam itself in a similar manner. Von Hippel,<sup>117</sup> out of forty cases of injuries due to explosions of dynamite, has reported twenty-one instances of loss of one eye and seven cases of loss of both eyes. Subconjunctival hemorrhages, opacities of the cornea, and superficial burns of the ocular envelopes are among the most common conditions. Rivers's patient, who received a discharge of five hundred and fifty volts (and one thousand ampères), had a deep burn of the face, and lost consciousness. The lesions of the cornea and of the conjunctiva in this case were slight, but photophobia with rapid fatigue of vision persisted for some time after the accident.<sup>118</sup>



## PART THIRD.

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### CHAPTER I.

#### SIMULATED OR EXAGGERATED AFFECTIONS OF THE EYE.<sup>119</sup>

IN another publication<sup>120</sup> the author has stated that simulation belongs to all ages, and constitutes—so to speak—one of the attributes of the human race. In fact, individuals are seen every day trying, by many more or less ingenious plans, either to avoid necessary obligations, such as military service, for example, or to escape certain social duties, or, more frequently, to exaggerate the consequences of traumatism in order that they may be able to claim higher grades of damages. Some subjects who are without resources and are unwilling to work, at times assert a complete amaurosis so that they may be able to obtain pensions or gain admission into charitable institutions. Again, especially the nervous and the hysterical types, as one of the results of disappointment, vengeance, fantasy, etc., claim that they have become suddenly and completely blind, or else provoke and continue some form of inflammation of the external membranes of the eye. Moreover, children who find school-life irksome not infrequently complain of fictitious visual troubles.

The author, as ophthalmic surgeon to the Board of Charities of the City of Lille, is often called upon to examine the poor who solicit the aid of money that is appropriated for the relief of the blind and the partly blind. In

this capacity he has frequently noticed how often the best measures of charity that are made in favor of the needy run counter to the humanitarian end that has been held in view. Some years ago a considerable number of individuals intentionally neglected to consult their medical specialist, while others refused to follow courses of treatment which, though intended to lead them to recovery, would have deprived them of all monthly income. Force of circumstances have led the administration to refuse financial aid to the so-called "half-blind," since which time the ever-increasing crowd of claimants for charity at the author's clinic has given place to patients who are anxious to be cared for and to recover.

"Workmen," as Nieten has stated, "do not consider the indemnity which is given to them as an adequate compensation for the injury that has been sustained. They strive to increase their resources by means of the accident that has happened to them. To this end they at times endeavor to retard their recovery for long periods of time, in order that the importance of an injury may be increased. Again, they often exaggerate the magnitude of the slightest symptoms, and frequently feign the existence of visual troubles that are not present.

"Thus, for example," he says, "since the promulgation of the insurance laws of 1884, an increase of 25 per cent. in the number of cases of disease that are due to accidents has been noted in the one district of Saarbrück, while the ratio of the period of duration of treatment in such cases has increased some 30 per cent., the number of cases of ordinary affections having remained exactly the same."<sup>121</sup>

Among the diseases that patients feign in order to be adjudged absolutely incapable of work affections of the eye have always held an important place. This, in measure, is

so because slight lesions of the visual apparatus often constitute the most important of the serious obstacles to the exercise of a great number of professions. It is necessary, therefore, that the medical expert should know how to detect malingering.

In the present condition of the science and art of medicine there are a number of methods of making an almost certain diagnosis and of relieving pain.

On the other hand, care must be taken not to pass to the extreme of considering every patient a malingerer, while too much prudence and discretion cannot be exercised in the employment of tests during the examination of a patient. The difficulty of detection is greater when the degree of visual impairment must be determined among skillful pretenders who have had long experience or whose acuity of vision in one eye differs markedly from that in the other. On the contrary, the task of the medical expert is comparatively easy when he is dealing with ignorant subjects, because, in this type of cases, the complained-of troubles are not, as a rule, at all proportional to the degree and the character of the objective symptoms. Thus, for example, some types of patient may declare that they cannot distinguish daylight from darkness when the reactions of the irides are absolutely normal. Again, such individuals may assert that the local manifestations of general disease are due to accidents, shock, etc.

Simulated and exaggerated disorders of the eye are numberless. In this chapter only the principal affections that are simulated at the time of a real or a supposed traumatism of the eye or of a more distant region will be considered. Moreover, it will be impossible in the scope of present work to make more than a cursory study of differential diagnosis between such disorders.

Twice only has the author had occasion to observe a simulated form of a conjunctivitis. In one case the condition was provoked and maintained by the instillation of a strong solution of sulphate of copper, and in the other it was obtained by the introduction of the ashes of ordinary smoking tobacco. These two patients were not inclined to work; they were insured against accidents, and they were, moreover, members of a society for mutual aid. The reasons can be better understood when it is considered that the benefits they received from these sources of revenue were greater than the amounts they could have obtained from their legitimate wages. In consequence, they did their best to prolong an affection which enabled them to live without work.

For the purpose of producing inflammation of the eye, malingerers often introduce foreign bodies, chemical agents, and other irritants into their conjunctival *cul-de-sacs*. The substances most frequently employed are fine particles of sand, grains of powder, bits of ash, tobacco-juice or euphorbium-juice, turpentine, lime, corrosive-sublimate powder, sulphate of copper, lemon-juice, and urine. Some of these materials give rise to merely an hyperemia, without hypersecretion. Others are more violent in their action and produce a true conjunctivitis, which is characterized by epithelial desquamation.

In such a condition, particularly of monocular and rebellious type which without any apparent reason becomes worse suddenly and in a subject whose interests tend to lead him to practice deception, a detailed examination of the conjunctival membrane, particularly of the upper *cul-de-sac*, should be carefully made, in order to determine the presence of foreign bodies or to discover the traces of substances that may have been purposely introduced. In some

cases it may be advisable to apply an occlusive bandage and keep a strict watch upon the patient's movements so that he may not be able to continue any imposture.

Much more frequently, workmen, who have such a condition as granular conjunctivitis or some other type of chronic lesion of the external membranes of the eye, endeavor to refer the long-standing condition to a recent accident. Similar attempts are quite often made even in simple cases of ordinary catarrhal conjunctivitis, or keratitis, particularly when the patient is insured against accidents.

In most cases in which a traumatism affects the eye of a patient who is suffering from such a condition as conjunctivitis or a conjunctivitis of lacrymal origin, there is, as a rule, produced so slight an increase in the previous pathological condition that there can be but little doubt in each individual case as to the probable degree of the severity of the injury itself. On the contrary, a conjunctivitis that is symptomatic of a wound, a burn, or the presence of a foreign body in the conjunctival membrane, is usually sufficiently characterized in its principal symptoms to give it a special symptomatology which is more or less certain as regards the nature and the type of the injury.

The question has often been asked: can the simple forms of traumatic conjunctivitis following the introduction of irritant materials into the conjunctival sac be differentiated from the catarrhal types of supposed spontaneous origin? It has been shown that, as a rule, the special signs of traumatic conjunctivitis are a tendency to localization of the objective symptoms, a speedy recovery, and the failure of the plans of treatment that are usually found to be efficacious in the idiopathic forms of catarrhal conjunctivitis. In general, however, it must be acknowledged that

the distinction is quite difficult. The history of the case is of the greatest importance; but, as it is so frequently falsified by such patients, the diagnosis quite often becomes very uncertain.

In the study of burns of the cornea and the conjunctiva it is most difficult to determine the exact nature of the caustic agent that has caused the injury, particularly if the history of the case be wanting. Especially is this true unless there are superficial incrustations of the burnt material, peculiarities of burns of the eyelids and of the face, and characteristic spots upon the clothing.

Traumatic pterygium, or false pterygium, as it is sometimes called, is very often associated with symblepharon. Usually it appears as the result of a cicatricial contraction of the conjunctiva following a loss of conjunctival substance from a wound or a burn which has involved both the cornea and an adjacent part of the conjunctiva. According to Fuchs,<sup>122</sup> it is quite easy to distinguish this form from the so-called true pterygium. The former type is located indifferently above or below the corneal margin in accordance with the position of the area of the desquamation, the apex of the growth being truncated and it remaining stationary when it has once become definitely organized.

It can be well understood how easy it is for certain types of workmen who are subjects of rheumatic, syphilitic, albuminuric, or diabetic dyscrasia to associate any slight form of ocular traumatism or inflammation with the effects of a systemic condition such as an iridochoroiditis or a retinochoroiditis, particularly when the organ is suddenly affected. Moreover, in general pathology there is a current belief that contusions predispose all organs and tissues to inflammatory processes. On the other hand,

Veneuil and others have distinctly shown the incontestable influence of traumatism in awakening constitutional and diathetic conditions. For example, this can be distinctly seen in a contusion of the eyeball in a rheumatic subject which has suddenly become worse without any apparent reason. The injury should be looked upon as the exciting cause of a condition which is the result of the dyscrasia.

Hemorrhages into the anterior chamber, the retina, the choroid, and vitreous humor cannot, as a rule, be considered of traumatic origin unless the cause has been elicited by a process of strict exclusion. Recent and indubitable evidence of lesions of the orbital margin or of the external coats of the eyeball itself must in most cases be shown, while general and local affections—such as are ordinarily produced by diseases of the circulatory and the respiratory systems: for example, dysmenorrhea, menopause, chlorosis, anemia, gout, rheumatism, diabetes, and albuminuria; as well as purely local conditions, such as glaucoma, iridochoroiditis, and high myopia—must all be eliminated.

Since traumatic cataract is, in general, the result of a direct form of injury to the crystalline lens by a body that has perforated the cornea and the iris, or the cornea alone, an examination with oblique illumination will often be of assistance in making an etiological diagnosis. This is done by revealing, according to the date of the accident, of either a simple or an adherent form of leucoma, a recent or an old wound of the cornea, a laceration or a detachment of the iris-tissue, or the presence of a foreign body in the cortical layers of the lens itself.

Cataract that is supposed to be due to a shock of the lens often has the appearance of a spontaneous form of opacity. This is so on account of the slowness of its

growth. This fact frequently enables a malingerer to endeavor to attribute a constitutional type or a symptomatic form of cataract to a contusion of the eyeball, to a shock of the head, or to a fall upon the feet; in brief, to a supposed related form of traumatism.

Systemic forms of cataract, such as are seen in diabetes, or those that are simply expressive of such local conditions as chorioretinitis, retinal detachment, glaucoma, and intraocular tumor usually have sufficiently characteristic general and local signs that are diagnostic; so that the complainant can rarely deceive the observer.

Congenital cataract exists from earliest infancy, and is generally found in both eyes.

The question of determining whether certain types of displacements of the crystalline lens without any apparent rupture of the ocular membranes are of traumatic origin or not is of great importance in legal medicine.

In the first case, if the luxation is exclusively the result of the action of some projectile or of a violent blow in the orbital region, the most careful examination made immediately after the accident does not, as a rule, show any trace of previous affection in either eye, the displaced lens nearly always preserving its transparency. In such a case the traumatism is most probably the sole cause of the condition.

When, however, a chronic form of inflammation of the uveal tract is followed by a contraction of the vitreous humor, altering the suspensory ligament of the crystalline lens and disturbing the relationship between the aqueous humor and the vitreous humor, the slightest shock may be sufficient to displace the crystalline lens. In such a case a medical expert may not, as a rule, hesitate to state that the traumatism has been the immediate cause of a lesion to



which the eye has been predisposed by reason of a previous pathological condition.

When a detachment of the retina is accompanied by subretinal hemorrhages and extravasations of blood into the vitreous chamber associated with evidences of contusion upon the lids or eyeball in an eye that does not present any gross symptoms of local or systemic type, it may be safely concluded that the cause of the detachment of the retina has been traumatic in character.

Of all the feigned diseases of the eye, the most frequent ones are unilateral amaurosis and amblyopia. The simulator—the victim of an accident, for example—states that he is unable to see with one eye, or exaggerates a true weakness of vision which has existed before the accident, declaring—for instance—that he can see only well enough to walk alone, but not enough to work. In such a case the medical expert will be compelled to solve the three following questions: 1. Is the unilateral amaurosis or amblyopia real? If there is an amblyopia, what is its degree? 2. Is the amaurosis or the amblyopia of traumatic origin? 3. Will the more or less marked weakening of vision remain stationary; will it end in recovery or will it terminate in blindness?

As illustrative, let it be supposed, in the following description of the various methods that are employed, that the right eye is the one that is assumed to be affected.

After it has been made fairly certain that the amblyopia or the amaurosis cannot be explained by a lesion of the central nervous apparatus, by disturbances in the transparency of the intraocular media, or by errors of refraction, the condition of the pupil and the direction of the visual axes should be determined.

## (A) OBJECTIVE METHODS.

1. Condition of the pupil.<sup>123</sup> If the right eye is amaurotic and the retina is no longer sensitive to light-stimulus thrown upon it (the left eye being covered in such a way that it can be observed), it will be found that there is complete immobility not only of the iris of the right eye, but also of that of the left eye.

Under such circumstances, while the subject is in a darkened room the supposed amaurotic right eye is to be covered in such a way that it can be watched. This done, a beam of light is to be thrown upon the (good) left eye, varying the intensity of the illumination. This is to be followed by having the left eye fix upon an object that is placed directly ahead close to it and then to the nasal side. During these tests the pupil of the right eye will ordinarily contract.

The first of these results, however, becomes doubtful if the affected eye possesses quantitative degrees of light-perception, rendering an opinion uncertain, with a possibility of error against the patient. It is best in all cases to repeatedly employ several tests; the one controlling the other. If an eye possess a normal amount of visual acuity with pupillary dilatation, frequently it presents functional disturbances that are due to so-called dazzling, and, as a rule, will generally be found to have lost its power of accommodation. The method of arriving at a differential diagnosis in such cases is as follows: The patient is to be placed in a darkened room. Notice is then to be made particularly of the degree of contraction of the sphincter-muscle of the iris of the healthy eye. This eye is covered and a strong light-stimulus (best obtained by the aid of a convex lens) is projected upon the eye in which the

mydriasis is present. If the retina of the bad eye is insensitive, the pupil of the good one will not vary in size. If the bad eye is merely amblyopic, its iris will react slowly and slightly, while that of the fellow-eye may be quite active. If the visual acuity and the accommodative power of the supposed bad eye is normal, the contraction of its iris when the light-stimulus is thrown upon its retina will be as pronounced as if the pencil of light had been projected directly upon the good eye.

Artificial mydriasis is often produced for the purpose of shamming, and the medical expert should endeavor not to be deceived by it. In such cases the pupil is, as a rule, dilated practically to its maximum degree. At times a slight conjunctivitis due to the prolonged use of the drug may be present. When, however, a pretender is familiar with the effects of mydriatics, he generally employs a small quantity of the drug and discontinues its use some time before an examination is made in order to obtain but a moderate degree of pupillary dilatation. In such uncertain cases doubt is always admissible, and it must be seen that such a pretender does not have any access to such drugs.

In cases of artificial monocular mydriasis excitation of either retina does not produce any contraction of the dilated pupil.

An examination of the iris and of the pupil is important in all cases, although, as before shown, such a study does not enable the physician to determine positively the absolute condition of the retina.

In cases of supposed monocular amblyopia the examination of the iris and the pupil will give much less definite information than when simulation of unilateral amaurosis is being sought for. An amblyopic eye always possesses a quantitative degree of perceptive power. Unless, there-

fore, there is a true mydriasis, a more or less movement of the iris as compared with that of the iris of the pronouncedly sound eye will be found. It may be easily understood, however, that the differences of reaction will often be very slight, and that their interpretation is quite frequently both changeable and uncertain.

2. Direction of the visual axes. In normal binocular vision the visual axes converge in such a way as to allow their ends to meet upon any fixed object that makes an impression upon identical points of the two retinas; that is to say, upon the fovea centrales. Differences in the directions of the visual axes, however, result from paralysis, paresis, contraction, and spasm of one or more of the ocular muscles. Such affections fortunately are very difficult and oftentimes impossible to simulate during prolonged examinations. Acute paralytic strabismus most frequently co-exists with a normal degree of vision. Moreover, it is often transient and curable. In the chronic type, however, it is, as a rule, accompanied with a diminution of visual acuity or even with a true blindness. The same is true in the functional forms of strabismus, which, though often associated with an anomaly of refraction, are at times found to be consecutive to an amblyopia or an amaurosis.

In all such cases the medical expert should make a most careful examination, and have recourse to all the means of investigation that may be at his command. In addition, he should base his opinion upon repeated tests, the value and results of which cannot be questioned. Indeed, an indifferent or an ignorant observer may be easily baffled, for a patient who is affected with strabismus, for example, frequently has the faculty of disregarding an image that is perceived by an eye which he claims to be amaurotic.

In addition to the evidences that are furnished by objective observations, there are various subjective methods which can be employed for the detection of simulation. In this work the author will limit himself to the task of explaining only the most simple and the most practical of the tests that are used for the purpose, some of which merely expose the dishonesty of a subject, while others give *data* that enable the observer to determine quite accurately the actual amount of visual acuity that is possessed by the examinee.

#### (B) SUBJECTIVE METHODS.

A great number of subjective methods exist. These, as a rule, are dependent upon the properties of lenses, mirrors, and prisms (Harlan,<sup>124</sup> Javal, Snellen, and others). In these tests the patient is made to read characters with the supposedly-amaurotic eye which the sound eye is apparently gazing at, but which, by the aid of various contrivances, it cannot distinguish.

In most all of these tests it is taken for granted that the medical expert is placed in such a position as to be able to watch that the patient does not close one or the other of his eyes.

Among the best-known plans the following may be noted:—

1. A convex spherical lens of about sixteen diopeters' strength is placed before the healthy eye, and the subject is requested to read the letters on a distant test-card. If he does so, it must necessarily be accomplished with the eye which has been declared to be bad (Harlan).

2. A rule or a pencil is successively interposed between the sound eye and printed letters, numbers, or characters of different sizes, so as to make some of them invisible to

that eye. If the patient is able to read the types correctly he is using the averred bad eye, and the simulation is at once revealed (Javal). The necessity of an absolute immobility of the head of the patient and the reading-card is the great objection to this method.

3. The subject is placed before a series of Snellen's test-types printed in white, red, and green upon a dull, black ground. These are gazed at in various ways through red and green glasses. The red characters are rendered invisible when they are looked at with a green glass, while the green ones cannot be recognized when they are looked at through a red glass. During the tests the surgeon must act as if he does not doubt the assertions of the patient. Under the pretext of assuring himself that the sound eye acts properly, it is to be covered with a red glass, when the reading of the green letters (necessarily with the bad eye) will be an evident proof of deception. At the same time, if the test has been made in a proper way, the degree of visual acuity will have been obtained.

Before commencing this test the physician should see that the letters or characters on the cards have been made sufficiently plain, and that their tint agrees with that of the colored glass which is to be employed.

Many modifications of this procedure have been proposed, among which are those by Bravais, Dujardin, Stoeber, Nichard, and Minor.<sup>125</sup> They are all based upon the principle that a red mark upon a white ground becomes invisible when gazed at through a red glass. Having thus noticed that red glasses make letters of the same color invisible when they are written on a white ground, while, in addition, black characters are readily seen under such circumstances, Bravais<sup>126</sup> and Dujardin<sup>127</sup> have suggested a very simple and practical method of replacing the

tables of Snellen and Stilling. The subject, whose good eye has been covered by a red glass, is put before the ordinary tables, and satisfies himself, by shutting the bad eye, that the glass placed before the sound eye does not modify vision at all. If then, at the time of the examination, one or more words are written upon white paper in two colors (red and black letters) the red letters will be invisible if the supposedly bad eye is in reality amaurotic; while, if all of the words are seen and read, there is a direct proof of simulation.

In order to determine the actual degree of visual acuity in such cases Stoeber<sup>128</sup> has had a portable scale constructed. It is composed of six squares of red and green glass of the same size, behind which are pasted letters chosen from the decimal scale of Monoyer. These glass squares are arranged in alternate threes in two horizontal rows, and are fastened upon two pieces of cardboard that are fitted to one another by a hinge. The contrivance is small in size and is of moderate cost. If in front of this apparatus a frame (the left glass in which is red and the right one green) should be placed before the patient's eyes, it will at once become evident that the reading of the letters on the red squares will be impossible if the right eye is really amaurotic.

4. The procedures in this series of tests is accomplished by prisms. The plans are both cheap and valuable in the recognition of simulation, in which either a decrease in central vision or an eccentric shrinking of the visual field is complained of. In regard to simulation of contraction of the fields of vision, Schmidt-Rimpler<sup>129</sup> says: "While the test-object is situated on the limit of the line of demarkation of the visual field of the one eye, it may still be seen by the patient's other eye through a properly

arranged and graded prism. If the test-object is seen by both eyes, and if there is simulation, the patient will state that he sees two objects, the true one and its iridescent double, thus proving the simulation of any complained-of monocular blindness."

The author will dwell particularly upon a modification of the tests of Welz and of von Graefe, as they have seemed to him the most practical.

Welz's plan consists in placing a prism with its base outward before the complained-of eye. In order to secure a single image the right eye will deviate inward, and will become straight when the prism is removed: two movements that are incompatible with the absence of binocular vision.

An objective symptom which is more or less useful is obtained from a slight variation of the experiment. While a prism of twenty degrees' strength is being rotated before the pronouncedly-bad eye, the patient is requested to read some printed matter aloud. If binocular vision exists, the reading of very fine letters will be quite difficult, or at least there will be a marked hesitation during the procedure. (Berthold.)

The well-known test of von Graefe consists in producing a binocular diplopia by the aid of a prism. In such cases, lest the simulator should obtain some knowledge of the form of double vision that is caused by prisms, it is best to make the test in various ways at several different times. "At first," says Giraud-Teulon,<sup>130</sup> "the knowledge of the possibility of seeing two images with one eye is made to enter into the unconscious judgment of the patient under observation."

In the test the supposedly-bad eye is covered. A prism with its base either up or down is placed before the sound



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the 1990s, the number of people in the United States who are 65 years of age or older has increased by 50% (U.S. Census Bureau, 1997). The number of people aged 65 and older is projected to increase to 20% of the total population by the year 2020 (U.S. Census Bureau, 1997). The number of people aged 65 and older is projected to increase to 20% of the total population by the year 2020 (U.S. Census Bureau, 1997). The number of people aged 65 and older is projected to increase to 20% of the total population by the year 2020 (U.S. Census Bureau, 1997).

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the 1990s, the number of people in the world who are illiterate has increased from 1.2 billion to 1.5 billion. The number of illiterate people in the world is projected to reach 1.7 billion by the year 2015. The number of illiterate people in the world is projected to reach 1.7 billion by the year 2015.

the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.4 billion. The number of people aged 65 and over is expected to increase from 200 million to 400 million. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion.

1. *Journal of the American Medical Association*, 1997; 278: 1023-1028.

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1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Arar and Collins (1971). The *Chlorophyll a* and *Chlorophyll b* contents were expressed as  $\mu\text{g g}^{-1}$  of dry weight.

1. *Phragmites* (common)  
2. *Phragmites* (common)  
3. *Phragmites* (common)  
4. *Phragmites* (common)  
5. *Phragmites* (common)  
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9. *Phragmites* (common)  
10. *Phragmites* (common)

1. *Chlorophyll a* and *Chlorophyll b* were determined by the method of Arar and Collins (1971) using a Shimadzu 1010 spectrophotometer. The concentration of chlorophyll was expressed in  $\mu\text{g mL}^{-1}$  of the sample.

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entering into such a test with the worst grace possible, is forced to see the two flames. Instead of bringing the edge of the prism opposite the pupillary opening, the base of the prism is moved toward the circumference of the cornea of the good eye, and at a distance of ten or even twenty centimeters in front of the organ.

The test with the birefracting prism of Galezowski consists in provoking a monocular diplopia by means of the birefracting lens of d'Argo. The advantage of this prism is that it cannot be distinguished externally from an ordinary one, which is an important point in dealing with a simulator who is familiar with some of the preceding methods.

The various stereoscopic tests constitute merely another series of applications of the ordinary prism.

5. Tests with pseudoscopic mirrors. These are intended to make a subject read letters or see characters with the eye which he has said to be bad which he thinks that he sees with the good eye. In these tests mirrors are placed parallel to one another or in such a way as to form re-entering, or salient, angles between them. Various contrivances have been made on this principle, of which that of Flees as modified by Chauvel<sup>131</sup> may be cited. This test endeavors to fulfill the following conditions: To determine the visual acuity; to illuminate objects so as to favor a precise, though rapid, perception by a healthy eye; to place test-types at such a distance as not to require much accommodative effort; and to obtain by the aid of a simple mechanism the displacement of images, so that objects can, at the will of the examiner, be seen by either the right or the left eye of the subject.

An apparatus that has been devised by Nachet consists of a rectangular box which is closed by a hinged lid. The

contrivance is divided into two equal parts, which are held together by hooks. The box is so constructed that it is easy to open it and change its parts at will. The posterior wall of the box is formed by a plate of glass upon which are placed, at one centimeter's distance apart, two cardboard tables that contain graded letters. The cardboards may be replaced by tables of isolated letters and lines of given size of test-type.

The letters are illuminated by transmitted light, which may be either obtained from ordinary daylight or from a good artificial illuminant. The anterior wall of the box is furnished with two projecting lenses.

If the subject is able to read all of the lines easily, both his eyes must practically have the same degree of visual acuity, this amount being indicated by the smallest characters that are read. If he can read but one table, it can be varied in such ways as to readily deceive the observer.

Very rarely a pretender may complain of a sudden and an absolute loss of vision (double amaurosis). Such an imposter, however, must assume the attitude and gait of a blind man: walking stiffly and hesitatingly. His hand must be stretched out before him. His face must be impassive, and his expression must be dull. His eyes must be turned upward and his eyelids must be held immovable even before sudden flashes of bright light or if harmful objects are threateningly and quickly brought close to his eyes.

It must be remembered, nevertheless, in all such cases that, even if repeated examinations fail to reveal anything abnormal, and if it is to the patient's interests to deceive suspicion as to his honesty must be persisted in.

The symptoms that are furnished by the size and the shape of the pupillary openings and the play of the irides

are most important in all cases. If both pupils remain dilated and if the irides are immobile upon subjecting the eyes suddenly to beams of bright light, it may be presumed that there is probable blindness. In such cases it is often necessary to endeavor to obtain additional information—such as, for example, the duration of the assumed absolute loss of vision. If to such a question the answer is given that there has been blindness for a long period of time, it is well to make inquiry among disinterested parties in the patient's own neighborhood. Moreover, quite definite ophthalmoscopic lesions are ordinarily found in such cases. Where the blindness is said to be of recent date, and its appearance has been asserted to be sudden, no gross organic lesion may be visible. In these types sufficient time must be allowed to elapse before any opinion is given.

Frequently in such cases both eyes may be advantageously kept closed by a compression bandage, and a strict watch kept in order to discover the existence of deceit, as such a test will be only easily endured by those who are really blind.

As a rule, it will be found that the pretender will find it more convenient to tell an examiner that he has sufficient vision to enable him to see to walk alone (double amblyopia).

The solution of the other questions that are put to the medical expert should be furnished by an exact and thorough knowledge of the internal and the external diseases of the eye, and by an exhaustive comparative study of the ophthalmoscopic lesions of the various pathological conditions.

At times, the questions arise: is an amaurosis or an amblyopia exclusively of traumatic origin? is it the result of a chronic systemic process? and will it remain stationary,

end in recovery, or terminate in permanent blindness? For the better answer of these questions a careful history of the case is important.

Although various theories in regard to so-called shock exist, yet the whole question is still in dispute. It is certain, however, that the shock which affects the victims of railway accidents, for example, becomes the starting-point, as it were, of certain obscure functional disorders of a psychical sensori-motor, and sensory nature, among which are various ocular disturbances. With many diverse manifestations, there may be associated symptoms which indicate lesions of the central nervous system or gross important viscera.

Typical traumatic amblyopia or hysterotraumatic amaurosis, which is usually unilateral at first, is characterized by an absence of definite anatomical lesions, by a diminution of direct vision, and by a concentric narrowing of the visual fields for white and colors with an inversion of the sequence of the color-series. To these symptoms may be added a whole series of more or less temporary signs, such as paralysis of convergence, strabismus, accommodative asthenopia, spasm of the sphincter-muscle of the iris and of the ciliary muscle, diplopia, monocular polyopia, astigmatism, pupillary inequality, macropsia or micropsia, hemianopsia, and erythropsia.

As a rule, amblyopia is unilateral at first, but later it becomes bilateral and is generally more pronounced on the hemianesthetic side. The same is true of contraction of the visual field, which is generally concentrically diminished in size. Usually there are variable degrees of decrease of the light and the color-senses, presenting quite frequently the phenomena of transference. Only very rarely is an increase in the visual field observed in connection with an augmenta-

tion of the light- and the color- senses (Fränkl-Hochwart and Topolanski<sup>132</sup>).

According to Charcot, concentric contraction of the visual field is not met with outside of hysteria, except as the result of epileptic attacks or in lesions of the posterior segment of the internal capsule, in which hemianesthesia is found.

Asthenopic disturbances with spasm and paresis of accommodation are quite common and, as a rule, are very persistent; but they are exceedingly variable in intensity. Most patients of this class of cases complain of migraine and increased tension about the eyes, with ocular and orbital pain. At times, the most prominent symptoms are photophobia, dazzling, cephalalgia, and double vision. Very often there are, in addition, spasm of the orbicularis muscles, slight degrees of ptosis, lacrymation, corneal and conjunctival anesthetics, and marked injection of the conjunctival membranes.

Almost all such patients present general manifestations, such as hemianesthesia, analgesia; reflex disturbances, attacks of palpitation, and fibrillary tremor of the muscles of the upper extremities and the lips. At times there are persistent insomnia, gastro-intestinal symptoms (Bouveret), perversion of smell and taste, and disturbances of speech.

The presence of this type of general symptoms in patients supposed to be neurotic by inheritance and who fail to evidence any taint of alcoholism and syphilis greatly justifies the physician in making a diagnosis of hysterotraumatic amblyopia or amaurosis where such ocular signs are complained of.

On the other hand, the fact that the subject has not any appreciable lesion of the eye, that he has normal pupillary reflexes, and that, although he says he is amau-

rotic, he nevertheless has been found to possess binocular vision, give the medical expert the right to suppose that the case is one of conscious or unconscious simulation.

Simulation of concentric contraction of the visual field and of hemianopsia is quite difficult to determine. To unveil such a fraud, it is necessary to obtain the relative limits of the various visual fields at varying distances. In this experiment the subject will often expose himself by claiming that he is able to recognize test-types, for instance, at the same place upon a perimeter no matter what may be the angular deviation that is employed. It is easy, however, to control the results of such tests by making use of prisms.

The prognosis of hystero-traumatic neurosis and of the ocular disturbances which accompany it is most uncertain. For example, minor types of accident, such as the mere penetration of a chip of iron into the corneal membrane, which is removed at once (case of Borel), or slight contusions of eyes (Baquis<sup>133</sup>), may be susceptible of a sudden aggravation of reactionary signs as the result of hysteria which may apparently render the patient incapable of using the eye for a period of many weeks or months.

Hystero-traumatic phenomena about the eye are, as a rule, particularly obstinate, and often resist therapeutic efforts for long periods of time. Relapses, moreover, are quite apt to take place whenever there is an exacerbation of the nervous disturbances. The medical expert should, therefore, give his opinion cautiously. In some cases, however, recovery may take place quite suddenly, allowing the patient to resume his usual occupations; while, on the other hand, the conditions may be prolonged for considerable periods of time, and the psychical disturbances may become permanent.

## PART FOURTH.

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### MEDICO-LEGAL EXPERT TESTIMONY.

Translated, rewritten, and adapted to the Courts of the United States of America by CHARLES SINKLER, Esq.,  
of the Philadelphia Bar.

It is not purposed to present in this chapter an exhaustive and technical treatise on the subject of expert testimony, but rather to indicate briefly the principles that govern opinion-evidence. It is desired to discuss the method of examining medical experts in the endeavor to inform the practitioner as to the nature of questions likely to be asked of him when summoned as an expert witness. The outline is: I. Expert evidence in general. II. Medico-legal experts. III. A few cases in which expert testimony relating to the eye has been offered. IV. Procedure in the examination of experts. V. Expert testimony in cases of malpractice. VI. Proposed legislation on the subject.

I. As to expert evidence in general. A principle of the law of evidence is stated by an authority on the subject as follows: "The fact that any person is of opinion that a fact in issue does or does not exist is deemed to be irrelevant."<sup>134</sup> That is, matters of opinion are inadmissible. But the same writer notes an exception to this rule: "Where there is a question as to any point of science or art, the opinions upon that point of persons specially skilled in any



such matter are admissible. The words science or art are taken to include all subjects on which a course of special study or experience is necessary to the formation of an opinion. But opinions of experts are admissible only in relation to their art, and not as to matters of common knowledge."

It is not necessary, in order to call an expert, that the subject of his special knowledge be abstruse or recondite. Thus, tailors, gardeners, blacksmiths, and others of kindred calling have been allowed to testify as experts concerning matters within the scope of their particular knowledge.

Expert testimony is admissible when the subject-matter of inquiry is such that inexperienced persons are unlikely to prove capable of forming a correct judgment upon it without such assistance; in other words, when it so far partakes of the nature of a science as to require a course of previous habit or study in order to the attainment of a knowledge of it.<sup>135</sup>

Opinion-evidence of expert witnesses may be offered by either party at any time in a cause at issue. But whether or not the subject is a proper one for such testimony, whether or not the witness called is qualified to testify as an expert, and the manner of his examination are questions resting within the discretion of the court. The weight to be given to the evidence, when admitted, the jury is to determine. The jury are at liberty, if they see fit, to disregard the expert testimony and form their own conclusions upon the matter in hand.

II. Medico-legal experts. The opinions of medical men are constantly admitted as to the cause of disease or death or the consequences of wounds, or the treatment of sickness; and as to the sane or insane state of a person's

mind as collected from a number of circumstances, and as to other subjects of professional skill.<sup>136</sup> But his special knowledge must be established and his examination confined thereto.<sup>137</sup>

Who is a medical expert? The term does not admit of a specific definition; but a few decisions on the point are indicative. In the first place, it is not necessary that he be the graduate of a particular school.<sup>138</sup> It is sufficient that he be shown a practicing physician. No definite rule can be stated as to what amount of experience or study is requisite to constitute an expert. His competency is a matter that is to be decided by the opinion of the judge sitting in the particular case. In some States, as in Pennsylvania, no persons are allowed to practice medicine without a diploma from a medical school capable of conferring the degree of doctor of medicine. It would seem that the same provision should apply to the competency of experts.

It is the better rule that a physician is not competent to testify as an expert concerning matters pertaining to a special branch of his profession unless he has devoted himself particularly to such branch. He is not an expert in a subject of his profession entirely out of the line of his usual practice and study. Thus, in an action against a gas-company for injury occasioned by escaping gas, a physician not having a special knowledge thereof was not permitted to testify as to the effect of illuminating gas upon the health.<sup>139</sup> In another case the court uttered a *dictum* to the effect that a physician who had devoted himself exclusively to one branch of his profession and had no particular experience in that subject concerning which he was called to testify,—as if an oculist were called to testify as to insanity,—he would not be competent.<sup>140</sup>

As to what should form the basis of the expert's testi-

mony in a particular case: the opinion, to be admissible, must be founded either on his own personal knowledge of the facts testified to in court or upon an hypothetical question.<sup>141</sup> His evidence as to facts must be the result of his own examination.<sup>142</sup> A physician may not give his opinion as to a case in which he was called in consultation and where his knowledge of the case is derived solely from the discussion with his fellow-consultant.<sup>143</sup> A physician's opinion is not admissible if based on statements made to him by parties out of court and not under oath.<sup>144</sup> This rule is modified in instances wherein the physician's opinion is founded upon statements made to him by the patient. Such an opinion is admissible. This is somewhat on the principle of the admissibility of dying declarations wherein impending death is assumed to preclude the possibility of falsehood. The theory is that the patient recognizes the importance to himself of giving to the physician all possible assistance toward forming a correct diagnosis.<sup>145</sup> The courts are suspicious, however, of statements made by patients to physicians when the examination is made for the purpose of his testimony, and have in some cases rejected testimony founded thereon.

It may be mentioned here that, in the absence of statutory provision to the contrary, a physician may be compelled to disclose any communication made to him in professional confidence.<sup>146</sup> Such provision to the contrary has been enacted in many of our States, including Pennsylvania.<sup>147</sup> But even where such statute exists a physician may testify as to such communications if his patient waives the right of suppression.

Where the expert's opinion is given in answer to an hypothetical question, such question must be based upon facts in evidence. A general discussion of a disease without

any reference to the probable effect thereof on the patient should be stricken out. The witness may not pass upon the testimony of other experts given at the hearing nor draw inferences therefrom.

What matters may an expert testify to? In general, physicians may state the nature and effect of the disease a person is afflicted with, its severity, ordinary duration, effects upon the general health; its cause and remedy, symptoms and characteristics<sup>148</sup>; but not the mere possible outbreak of some new disease or suffering having its cause in the original injury.<sup>149</sup> A physician may testify as to the extent of certain injuries, their results, permanency, probable recovery, the time when they were inflicted, and even the direction from which a blow was received.<sup>150</sup> He may give his opinion whether a blow was inflicted before or after death, the means whereby a wound might have been inflicted, and whether it probably caused death.<sup>151</sup> An expert witness may state his opinion as to the *cause of death* where such opinion is founded either upon personal knowledge of the case or upon a statement of the symptoms as given by others.<sup>152</sup>

A physician may describe the symptoms which appear upon the administering of any particular poison.<sup>153</sup> He may say whether death resulted from the effects of a poison or some other cause.<sup>154</sup> An expert has been permitted to prove blood-stains to be human or otherwise. Even as to whether hair is that of a human being or animal evidence has been given.

An expert may use diagrams and plates by way of explanation of his evidence.

III. The following cases which bear upon the special subject of treatment of the eye are appended as illustrating the kind of testimony adduced in such cases.

An action was brought for assault and battery. The physician who had been in attendance on the plaintiff was asked the question how the plaintiff's blindness could have been caused. He replied: "By gouging." This evidence was admitted, although it was shown that the witness was not a specialist in diseases of the eye.<sup>155</sup> It is submitted, however, that this decision is not to be taken as authority for the view that a non-specialist shall be accepted as an expert witness in a special subject. The question was one relating rather to general surgery than to the specialty. The better ruling concerning testimony as to special branches of medicine is found stated above.\* In a recent case a modified view was taken. There was an action for damages occasioned by negligence, which resulted in an injury to the spinal cord. A physician, not a specialist in diseases of this particular kind, was produced as a witness to testify in relation thereto. The court admitted him, but took the ground that, while he did not have the experience acquired by a specialist, this did not exclude his testimony entirely, but only affected the value of it.<sup>156</sup>

The following question to a medical expert was held to be admissible: "If an eye were inflamed violently for two weeks and caustic soda had gotten into it two months before, and there had never been anything the matter with the eye till that time, what was the probable cause of the trouble?" And the expert may then state his opinion as to what was the origin of the injury.<sup>157</sup>

In an action for negligence causing an injury to the plaintiff's eye, necessitating its removal, a medical expert may testify that in his opinion it was necessary to remove

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\* See page 135.

the eye to save the sight of the other, which was endangered by sympathetic inflammation.<sup>158</sup>

An expert physician was asked the question whether a man who had lost the sight of one eye would be as able to see certain events at a particular time and distance as would a certain person having the sight of both eyes. The court refused the testimony, inasmuch as the expert had not made an examination of the eyesight of the two witnesses.<sup>159</sup>

IV. M. Baudry describes in detail the method pursued by the French courts in examining experts. It is, in effect, the summoning by the court at the instance of a party, or, it may be, at the direction of the presiding judge, of three experts. These experts constitute a commission to hear the facts upon which their expert opinion is asked and report their conclusions to the court.

In the courts of this country the process as to expert witnesses does not differ from that used in the calling of other witnesses; that is, they are summoned by subpoena. The subpoena is a mandatory writ, directing the person named therein to appear before the court which issues it and give his testimony as to some matter therein pending or suffer a certain penalty. If the subpoena is ineffectual, an attachment of the witness's person may be enforced to compel attendance. It has been held that an expert duly subpoenaed and interrogated as such can be punished for contempt if he refuses to testify without receiving compensation other than the ordinary witness-fee.<sup>160</sup>

As already stated, the competency of the witness to testify as an expert is to be decided by the presiding judge, the weight to be given his evidence by the jury. If deemed competent, he is first examined *viva voce* by the party by whom he is summoned, then cross-examined by the opposite party; finally subjected to the redirect examination of the

first party. At any time during these examinations he may be questioned by the judge.

V. Expert testimony in suits for malpractice. A physician is required to exercise such reasonable care and skill as is ordinarily possessed and exercised by physicians in good standing of the same system or school of practice in the locality of his practice,<sup>101</sup> and for failure in such respect he is liable to suit. Whether a physician has in a given case adopted the proper treatment is a question on which the opinions of medical men of the same school may be received, and they may state whether in their opinion the treatment was or was not proper and whether or not it was in conformity with the rules and practice of the profession.<sup>102</sup> The expert may be asked whether the defendant gave the case such attention as it demanded "and whether there was any unskillful management on his part,"<sup>103</sup> and whether the whole treatment was proper or not.<sup>104</sup> But he may not testify as to the details and results of another similar case in his practice.<sup>105</sup>

VI. Proposed legislation on the subject of expert evidence. Expert testimony is peculiarly liable to abuse and misuse. However honest the witness may be, he is unconsciously biased toward the party who retains him. The present practice has been vigorously inveighed against by judicial utterances, by polemics from the mouths and pens of our judges when not acting in their official capacity, and by many lawyers. Their demand for reform in the method of calling and hearing opinion-evidence has been seconded by the experts themselves, medical and otherwise.

In a recent address by the Honorable Judge Endlich, of Reading, Pa., before the Pennsylvania Bar Association, the eminent judge thus summarized the proposed measures looking toward a reform in this matter:—

1. The formation of a stricter definition of expert capacity.
2. The reasonable limitation of the number of experts to be summoned in any case.
3. The designation of experts by the court upon nomination by the parties.
4. The abolition of the hypothetical question.
5. The summoning by the trial-judge of an expert of his own choice to serve as an assessor or as a witness to review the expert testimony already in, or as to both.
6. The payment of expert witnesses out of the public treasury, at least in the first instance.



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156. Cooper *vs.* Railway, 56 N. W. 42.
157. Flaherty *vs.* Powers, 167 Mass. 61.
158. Reed *vs.* City, 85 Wis. 182.
159. People *vs.* Marseiler, 70 Cal. 98.
160. Dixon *vs.* People, 168 Ill. 179.
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408. Mertz *vs.* Detweiler, 8 W. & S., 376. Heath *vs.* Gleson, 3 Oregon 67. Roberts *vs.* Johnson, 58 N. Y. 613.
163. Olmsted *vs.* Zere, 100 Pa. 127.
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165. Olmsted *vs.* Zere (*supra*).

## INDEX.

---

- Abscess in vitreous chamber, 89.  
Acids thrown into the eye, effects of, 16.  
Amaurosis and amblyopia, feigned, objective methods for detecting, 119.  
feigned, subjective methods of detecting, 122.  
hystero-traumatic, symptoms of, 130.  
unilateral, feigned, 118.  
Amblyopia, feigned, 118.  
objective methods of detecting, 120.  
following injuries to the head, 69.  
persistent, due to rupture of choroid, 67.  
traumatic, symptoms of, 130.  
Anterior chamber and the iris, foreign bodies in, 59.  
prognosis of cases of, 59.  
Atrophic and pigmented areas following interstitial hemorrhage into choroid, 64.  
Atrophy, bulbar, due to penetrating wounds of the sclera, 52.  
following rupture of the eye, 103.  
Atrophy of the eye caused by foreign bodies in the anterior chamber and the iris, 59.  
eyeball due to burns of the cornea, 39.  
following wounds in vitreous humor, 89.  
from iridochoriocyclitis, 62.  
Blindness caused by detonation, 106.  
caused by gunpowder, 107.  
due to detachment of the retina, 76.  
penetrating wounds of the sclera, 48, 51.  
following luxation and avulsion of the eyeball, 104.  
following wounds in vitreous humor, 89.  
from contused wounds of the eyebrows, 4.  
lesions producing, 5.  
detachment of vitreous humor and retina by hemorrhage, 65.  
Blood-vessels of the orbit, laceration of the, 24.  
Burns, deep, of the eye by quicklime or acids, results of, 17.  
of the cornea, 39.  
and conjunctiva, determination of the caustic which has caused, 113.  
deep forms of, 40.  
superficial forms of, 40.  
of the conjunctiva, 16.  
by alcohol-flames, 18.  
Burns of the eye by mortar, 16.  
of the eyebrow, 8.  
of the eyelids, 13.  
results of, 13.  
superficial, of the ocular envelopes produced by explosions, 109.  
Cataract, distinction between traumatic and other forms of, 117.

- Cataract due to foreign body in crystalline lens, 86.  
     the deflagration of gunpowder, 107.  
     traumatic, 79.  
         causes of, 79.  
         complications of, 80, 82.  
         consequences of complications of, 83.  
     due to prolonged operative procedures, 60.  
     etiological diagnosis of, 116.  
     produced by gunpowder, 107.  
     produced by penetrating wound of the cornea, 47.
- Cerebral disturbance complicating luxation and avulsion of the eyeball, 104.
- Chemosis complicating traumatic cataract, 82.  
     traumatic, 14.
- Choroid, cicatrix of, following rupture, 66.  
     detachment of, following wounds in vitreous humor, 89.  
     hemorrhagic detachment of, 64.  
     interstitial hemorrhage of, 63.  
     laceration of, accompanying injuries of the iris, 57.  
     rupture of the, 65.  
         followed by amblyopia, 67.  
         scotomata in, 67.  
         prognosis of, 66.  
     traumatic hemorrhages in, 63.
- Choroidal ruptures, prognosis of, 66.
- Cicatrices following isolated ruptures of the retina, 71.
- Cicatrix following rupture of choroid, 66.  
     wounds of the retina, 68.
- Ciliary body, foreign bodies in the, 61.
- Ciliary body, wounds of the, 61.  
     due to rupture of the sclerotic, 55.
- Colobomata, 57.
- Color-perception, subnormal, following injuries to the head, 69.
- Complex lesions of the eyeball produced by fire-arm wounds, 105.
- Compression of the optic nerve in contused wounds of the eyebrows, 5.
- Conjunctiva, burns of, 14.  
     by alcohol-flames, 18.  
     by metals, 18.  
     by steam, 18.  
     complications of, 18.  
     ecchymosis of, 14.  
     foreign bodies in the, 14.  
     foreign bodies long remaining in, 15.  
     prognosis of injuries due to foreign bodies, 15.  
     traumatic extravasations into, 14.  
     diagnosis of, 14.  
     wounds of the, 15.
- Conjunctivitis, simulated, 113.  
     traumatic and spontaneous, differential diagnosis of, 114.
- Contraction of the visual field, simulation of, 132.  
     due to foreign bodies in the vitreous humor, 91.
- Control test in examining eye for feigned amaurosis, 119.
- Contusion, luxation, and avulsion of the eyeball, 97.  
     of the base of the orbit, 20.  
     prognosis of, 20.  
     of the eyebrow, epileptic attacks in, 7.
- Contusions of the cornea, 33.  
     of the eyelids, 10.

- Cornea, burns of the, 39.
  - prognosis of, 39.
  - contusions of the, 36.
    - results of, 36.
  - foreign bodies in the, 37.
    - complications of, 38.
  - partial destruction of, complicating injury to the anterior chamber and the iris, 59.
  - penetrating wounds of the, 35.
    - complications and results of, 35.
  - pricking of, by metallic pen, 34.
  - scratches of, by finger-nail, 34.
  - traumatic lesions of the, 33.
    - opacities of, 34.
  - wounds and contusions of the, 33.
    - wounds of, by stone, 35.
    - the complications of, 34.
    - prognosis of, 35.
    - rare complications of, 36.
    - temporary results of, 33.
- Corneal fistula following wound, 36.
  - wounds, influence of diseases of the conjunctiva upon, 38.
- Crystalline lens, degeneration of, due to foreign bodies in, 88.
  - dislocation of, into the vitreous humor, 79.
  - displacements of, distinction between traumatic and other forms, 117.
  - expulsion of, through rupture of the sclerotic, 55.
  - foreign bodies in the, 85.
    - diagnosis of, 85.
    - effects of, 88.
    - prognosis of, 88.
  - incarceration of, by rupture of sclerotic, 55.
  - luxation and subluxation of, sympathetic complications of, 79.
- Crystalline lens, luxation of, accompanying injury of the iris, 57.
  - due to penetrating wounds of the sclera, 51.
  - opacification of, accompanying injury of the iris, 57.
  - opacification of, due to penetrating wounds of the sclera, 51.
  - opacity of, due to rupture of the sclerotic, 53.
  - rupture of the capsule of the, 78.
  - traumatic luxations and subluxations of, 77.
    - causes of, 77.
    - symptoms of, 78.
    - varieties of, 77.
  - varying effects of different kinds of foreign bodies in, 87.
- Cyclitis, sympathetic, from iridochoriocyclitis, 62.
- Cysts of the iris following wound of cornea, 36.
- Death following wound of the cornea, 36.
  - from contused wounds of eyebrow, 3.
- Dilation, paralytic, of the pupil, following contusion of the eyeball, 101.
- Ecchymosis of conjunctiva, 14.
- Enophthalmos and diminished visual acuity in contused wounds of eyebrow, 8.
  - following contusion of the eyeball, 104.
  - produced by fire-arm wounds, 105.
- Erosions of cornea following contusion of eyeball, 102.

- Erysipelas complicating contused wounds of eyebrow, 3.
- Expert evidence in general, 133.
  - proposed legislation on the subject of, 140.
- Expert testimony in suits for malpractice, 140.
  - relating to the eye, 137.
- Experts, procedure in the examination of, 139.
  - medico-legal, 134.
- Extravasations, traumatic, into conjunctiva, 14.
- Eye, atrophy of the, caused by foreign bodies in the anterior chamber and iris, 59.
  - retina and choroid, 75.
  - following wounds in vitreous humor, 89.
  - destruction of, by foreign bodies in the retina and choroid, 75.
  - due to foreign bodies in the vitreous humor, 93.
  - loss of, due to penetrating wounds of the sclera, 51.
  - of, from injury to ciliary bodies, 61.
  - of, produced by explosions, 109.
  - old disease of, referred to recent accidents, 114.
  - rupture of the, by violent contusions, 103.
  - simulated or exaggerated affections of the, 110.
- Eyeball, avulsion of the, 103.
  - contusion, luxation, and avulsion of the, 97.
  - contusions of the, complications following, 102.
    - prognosis of, 103.
    - symptoms of, 101.
  - injuries of the, by detonation, 106.
    - caused by fire-arms, 105.
- Eyeball, injuries of, caused by fire-arms, complications following, 105.
  - luxation and avulsion of the, complications of, 103.
    - prognosis of, 104.
  - luxation of the, 103.
  - powder-burns of, 106.
    - in relation to the point of explosion, 107.
  - wounds of the, 104.
- Eyebrows, burns of the, 8.
  - contused wound of, adherent cicatrix in, 6.
  - blindness from, 4.
  - complicated by erysipelas, 3.
    - suppuration of orbital connective tissue, 3.
  - compression of the optic nerve in, 5.
  - death from, 3.
  - diagnosis of, 3.
  - enophthalmos in, 8.
  - epileptic attacks in, 7.
  - fistula as a result of, 3.
  - from a medico-legal point of view, 8.
  - keratitis due to, 8.
  - lesions producing blindness in, 5.
  - neuroses of, 3.
  - osteitis as a result of, 3.
  - prognosis of, 3.
  - retrobulbar neuritis in, 5.
  - traumatic hysteria in, 9.
  - treatment of, 3.
- contusions of, 1.
  - complicated, 1.
  - facial paralysis in, 7.
  - hemiatrophy in, 7.
  - neuralgia in, 7.
  - tetanus in, 7.
  - trismus in, 7.
  - wounds of the supraorbital nerve in, 7.
  - wounds of, by projectiles, 8.
- Eyelids, burns of the, 10, 13.
  - results of, 13.

- Eyelids, contused wounds of, 12.  
     results of, 12.  
     contusions of the, 10.  
     differential diagnosis of, 10.  
     wounds of the, 10.  
     by pointed instruments, 11.
- Fistula as a result of contused  
     wounds of eyebrow, 3.
- Foreign bodies in the anterior  
     chamber and iris, 59.  
     prognosis of, 3.  
     conjunctiva, 14.  
     crystalline lens complicating  
         traumatic cataract, 83.  
     interior of the eye due to  
         penetrating wounds of  
         the sclera, 51.  
     orbit complicating luxation  
         and avulsion of the  
         eyeball, 104.  
     penetrating the orbit, 25.  
     complications of, 26.
- Fractures of the orbit produced  
     by fire-arm wounds,  
     105.  
     of orbital wall, 21.  
     complicating luxation and  
         avulsion, 104.  
     direct, 22.  
     effects of, 22.  
     effects of, upon vision, 21.  
     indirect, 21.
- Glaucoma, chronic, due to sub-  
     luxation of the crystalline  
     lens, 78.  
     complicating traumatic cata-  
     ract, 83.  
     due to burns of the cornea,  
     40.  
     due to dislocation of crystal-  
     line lens, 79.  
     from wounds of the cornea,  
     35.
- Hematoma, orbital, significance  
     of, 20.
- Hemianopsia, simulation of,  
     132.
- Hemorrhages into the anterior  
     chamber, distinction  
     between traumatic and  
     constitutional, 116.  
     choroid, distinction between  
     traumatic and constitu-  
     tional, 116.  
     retina, distinction between  
     traumatic and constitu-  
     tional, 116.  
     vitreous chamber, prognos-  
     is of, 64.  
     humor, distinction be-  
     tween traumatic and  
     constitutional, 116.  
     in the retina, traumatic,  
         symptoms of, 70.  
     intraocular, due to penetrat-  
         ing wounds of the  
         sclera, 51.  
     subconjunctival, produced by  
         explosions, 109.  
     subretinal, prognosis of, 64.
- Hemorrhagic effusion beneath  
     the conjunctiva follow-  
     ing contusion of the  
     eyeball, 102.  
     into the anterior chamber  
     following contusion of  
     the eyeball, 102.  
     into the vitreous humor fol-  
     lowing contusion of the  
     eyeball, 102.
- Hernia of the iris and choroid  
     following rupture of  
     the sclerotic, 52.
- Hyalitis due to foreign bodies  
     in the vitreous humor,  
     93.  
     plastic, following wounds, 89.  
     suppurative, 89.
- Hyphemia, accompanying fis-  
     sure or laceration of  
     the iris, 57.
- Hysteria, traumatic, in contused  
     wounds of eyebrow, 9.

- Hystero-traumatic neuroses and associated ocular disturbances, prognosis of, 132.**
- Inflammation and suppuration of cornea following contusions of eyeball, 102.**
- Injuries to the nerves of the orbit, 24.**  
     optic nerve, 25.  
     results of, 25.  
     other parts of the eye complicating traumatic cataract, 83.
- Iridectomy, improvement of vision by, in foreign bodies in the anterior chamber and iris, 59.**
- Iridochoriocyclitis due to foreign bodies in anterior or posterior chamber, 88.**  
     from wounds of sclero-corneal margin, 62.
- Iridochoroiditis, diathetic, simulating traumatic, 115.**  
     due to penetrating wounds of the sclera, 47, 52.  
     from wounds of the cornea, 35.  
     suppurative, due to injury of the ciliary body, 61.
- Iridocyclitis, chronic, from dislocation of the crystalline lens, 79.**  
     due to rupture of the sclerotic, 55.  
     following iridodialysis, 57.  
     following wounds of the eyeball, 104.
- Iridodialysis, 56.**
- Irideremia, 56.**
- Iridoplegia following contusion of the eyeball, 101.**
- Iris, detachment of, due to traumatism, 56.**  
     fissures of the, congenital, 57.  
     due to traumatism, 57.  
     incarceration of, due to penetrating wounds of the sclera, 51.  
     injuries to the, by contusion, 56.  
     laceration of, due to traumatism, 57.  
     retroversion of, due to traumatism, 57.  
     tissue, expulsion of, through scleral rupture, 56.  
     wounds of, complicated by injuries to the crystalline lens, 58.  
         made by pointed and cutting instruments, 58.
- Iritis, complicating traumatic cataract, 82.**  
     due to foreign body in anterior or posterior chamber, 88.  
         the vitreous humor, 93.  
         prolonged operative procedures, 60.  
     following iridodialysis, 57.
- Keratalgia, traumatic, 33.**
- Keratitis due to foreign bodies in the cornea, 18.**  
     following infectious pricks of crystalline lens, 82.  
     ulcerative, due to luxation or subluxation of the crystalline lens, 79.  
     ulcerative with hypopyon, due to foreign bodies in the cornea, 38.
- Lacerations of the choroid following contusions of the eyeball, 102.**  
     eyelids complicating luxation and avulsion, 104.

- Lacerations of the eyelids due to the deflagration of gunpowder, 107.
- iris following contusions of the eyeball, 102.
- retina following contusions of the eyeball, 102.
- Lacrymal gland and sac, injuries to, 31.
- results of injuries to, 31.
- Leucomata from wounds of cornea, 35.
- Leucomata due to burns of the cornea, 40.
- contusion of the cornea, 37.
- foreign bodies in the cornea, 38.
- Loss of eye from wounds of eyeball, 104.
- of sight following isolated ruptures of the retina, 71.
- Luxation of the crystalline lens complicating traumatic cataract, 83.
- following contusions of the eyeball, 102.
- Malingers, substances employed by, 113.
- Meningo-encephalitis from injuries to vault of orbit, 21.
- produced by fire-arm wounds, 105.
- Metallic foreign bodies in retina, effect of, 75.
- Metamorphopsia due to retinal hemorrhage, 70.
- from traumatic detachment of retina, 72.
- Mydriasis, artificial, for purposes of deception, 120.
- paralytic, accompanying fissure or laceration of the iris, 57.
- persistent, following contusion of the eyeball, 102.
- Necrosis as a result of contused wounds of eyebrow, 3.
- of the cornea due to contusion, 36.
- burns, 30.
- Neuralgia in contusion of the eyebrow, 7.
- local, following contusion of the eyeball, 102.
- Neuritis, retrobulbar, following contused wounds of the eyebrow, 5.
- Ocular muscles, rupture of, 24.
- Opacification of the crystalline lens following contusions of the eyeball, 102.
- Opacities of the cornea due to powder-burns, 45.
- produced by explosions, 109.
- Ophthalmitis due to burns of the cornea, 40.
- sympathetic, caused by foreign bodies in the anterior chamber and iris, 59.
- complicating injuries caused by projectiles, 105.
- due to foreign bodies in the retina and choroid, 76.
- in the vitreous humor, 93.
- due to injuries of the ciliary body, 61.
- due to wounds of the eyeball, 105.
- Optic nerve, atrophy of, following contusion of the eyeball, 69.
- injuries to the, 25.
- results of, 25.
- Orbit, blindness due to foreign bodies in the, 26.
- contusion of the base of the, 20.
- prognosis of, 20.



- Orbit, erysipelas due to foreign bodies in, 20.  
 foreign bodies in, prognosis of, 26.  
 foreign bodies penetrating in the, 25.  
   complications of, 26.  
 injuries to the nerves of, 24.  
   soft parts of, 23.  
   vault of, 20.  
     meningo-encephalitis from, 21.  
 laceration of the blood-vessels of the, 24.  
 meningo-encephalitis due to foreign bodies in, 26.  
 paralysis of ocular muscles produced by traumatism of the, 22.  
 phlegmon due to foreign bodies in, 26.  
 strabismus and diplopia due to foreign bodies in, 26.  
 tetanus due to foreign bodies in, 26.  
 thrombophlebitis, due to foreign bodies in, 26.  
 traumatism of, 19.  
 Orbital edge, traumatism of the, 20.  
   diagnosis of, 20.  
   symptoms of, 20.  
 Orbital hematoma, significance of, 20.  
 wall, fractures of, 21.  
   direct, 22.  
   effects of, 22.  
   effects of, upon vision, 21.  
   indirect, 21.  
   prognosis of, 21.  
   traumatic lesions of the, 19.  
 Osteitis as a result of contused wounds of eyebrow, 3.
- Palpebral edema complicating traumatic cataract, 82.  
 Pannus due to burn of the cornea, 41.
- Panophthalmitis complicating traumatic cataract, 82.  
 due to injuries of the ciliary body, 61.  
 following penetrating wounds of the sclera, 47.  
   rupture of the eyeball, 103.  
   wounds of the eyeball, 104.
- Paralysis, facial, in contusions of the eyebrow, 7.  
 of ocular muscles, produced by traumatism of the orbit, 22.
- Paresis of accommodation following contusion of the eyeball, 102.
- Perforation of the cornea due to contusion, 36.  
   powder-burns, 45.  
   ocular membranes due to the deflagration of gunpowder, 107.
- Photophobia produced by electrical discharges, 109.
- Phthisis bulbi produced by gunpowder, 107.  
 following hemorrhagic detachment of the choroid, 64.
- Pigment-spots following retinal hemorrhages, 70.
- Pigmentary infiltration of the retina following traumatism of the eye, 70.
- Polycoria, congenital, 57.
- Powder-burns of the cornea, 45.
- Pterygium, false, differential diagnosis from true, 115.  
   traumatic, differential diagnosis from true, 115.
- Pupil, condition of the, as an objective method for detecting feigned amaurosis and amblyopia, 119.
- Pupils, supplementary, 57.
- Purulent infiltration of the cornea complicating traumatic cataract, 82.

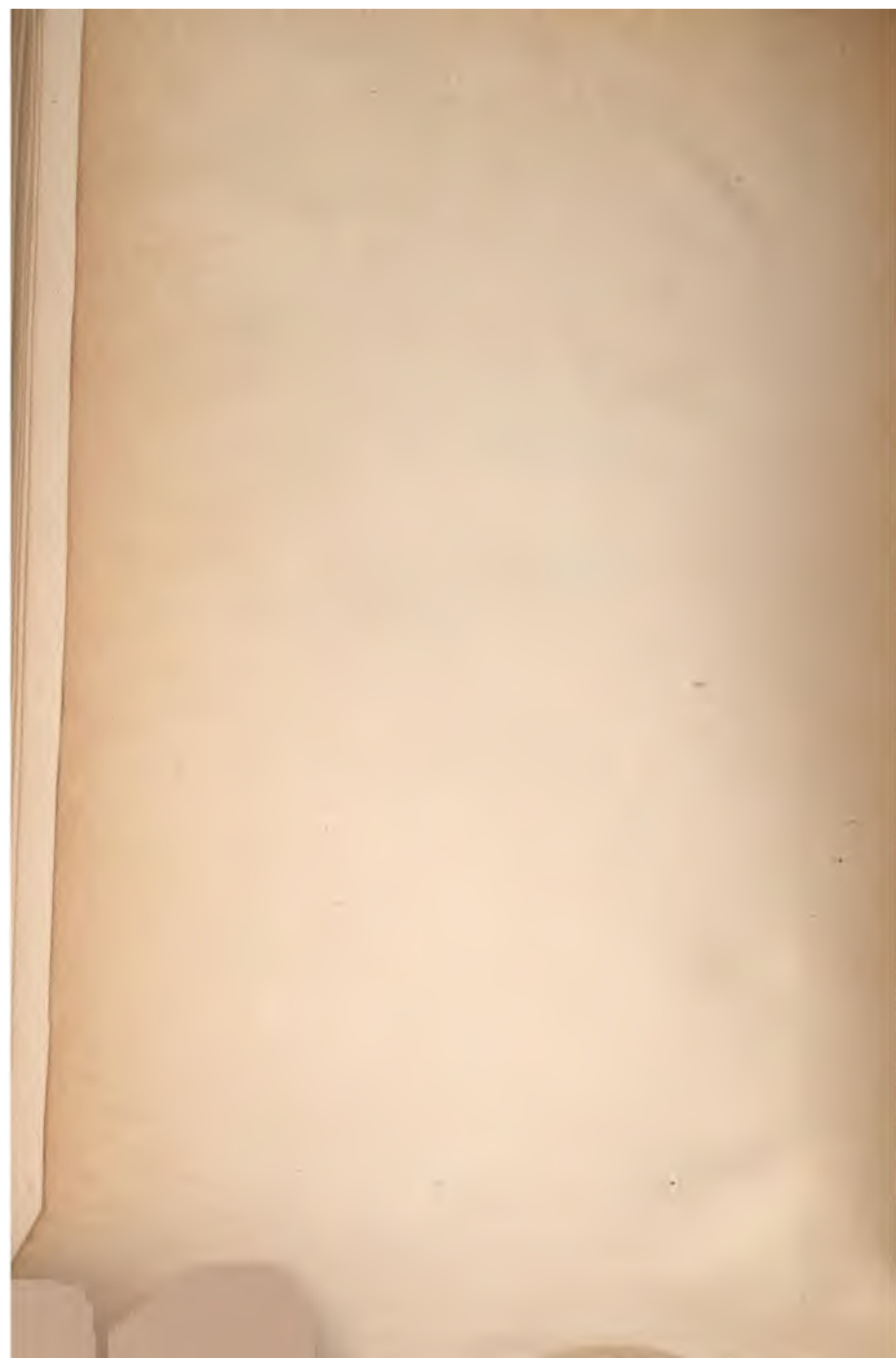
- Retina and choroid, foreign bodies in the, 72.  
     complications caused by, 75.  
     prognosis of, 74, 76.  
     atrophy of, due to large effusions, 70.  
     following contusions of the eyeball, 69.  
     cicatricial contraction of, following hemorrhage, 65.  
     detachment of, accompanying injuries of the iris, 58.  
     blindness due to, 76.  
     by foreign bodies in the retina and choroid, 75.  
     by large effusions, 70.  
     due to penetrating wounds of the sclera, 48, 51, 52.  
     due to penetrating wounds of the sclera, prognosis of, 53.  
     due to rupture of the sclerotic, 55.  
     following wounds in the vitreous humor, 89.  
     isolated ruptures of, 71.  
     loss of sight following, 71.  
     prognosis of, 71.  
     symptoms of, 71.  
     laceration of, accompanying injuries of the iris, 58.  
     rupture of, following extravasations into, 64.  
     shock of the, 68.  
     symptoms of, 68.  
     traumatic detachment of the, diagnosis of, 118.  
     metamorphopsia from, 72.  
     modes of production of, 71.  
     prognosis of, 72.  
     symptoms of, 71.  
     wounds of, followed by cicatrix, 68.  
 Retinal hemorrhages followed by pigment-spots, 70.  
     prognosis of, 70.  
 Retinitis, pigmentary, 70.  
 Retinochoroiditis, diathetic, simulating traumatic, 115.  
 Rupture of ocular muscles, 24.  
     of the capsule of the crystalline lens, 78.  
     following contusions of the eyeball, 102.  
     of the choroid, 66.  
     of the eyeball complicating luxation and avulsion, 104.  
 Ruptures, isolated, of the choroid, 65.  
     retina, 71.  
     of the zonule of Zinn following contusions of the eyeball, 102.  
 Sclera, burns of the, 47.  
     prognosis of, 47.  
     result of, 47.  
     foreign bodies in the, 46.  
     injuries to the, 46.  
     complications of, 46.  
     penetrating wounds of the, 47, 52.  
     complications of, 51.  
     prognosis of, 47.  
     rupture of, accompanying injury of the iris, 57.  
     multiple ruptures of choroid, 66.  
 Sclero-corneal margin, penetrating wounds of the, 62.  
 Sclerotic, rupture of the, 53.  
     consequences of, 54.  
     ultimate result of, 55.  
 Scotomata due to foreign bodies in the retina and choroid, 76.  
     vitreous humor, 91.  
     due to retinal hemorrhages, 70.  
     due to rupture of the choroid, 66, 67.  
     due to hemorrhages into the vitreous humor, 90.

- Section of muscles of the eye produced by fire-arm wounds, 105.  
 of the optic nerve produced by fire-arm wounds, 105.
- Spasm of the iris following contusions of the eyeball, 101.
- Staphyloma due to contusions of the cornea, 37.  
 due to foreign bodies in the cornea, 38.  
 following rupture of the sclerotic, 52.
- Suppuration due to penetrating wounds of the sclera, 52.  
 general, of the eyeball, due to foreign bodies in the vitreous humor, 92.  
 of orbital connective tissue complicating contused wounds of eyebrow, 3.
- Sympathetic conditions due to penetrating wounds of the sclera, 52.
- Synechia accompanying fissure or laceration of the iris, 57.
- Test (Bravais and Dujardin's) for feigned amaurosis and amblyopia, 123.  
 Galezowski's, for feigned amaurosis and amblyopia, 127.  
 Harlan's, for feigned amaurosis and amblyopia, 122.  
 Javal's, for feigned amaurosis and amblyopia, 122.  
 Schmidt-Rimpler's, for feigned amaurosis and amblyopia, 124.  
 Snellen's, for feigned amaurosis and amblyopia, 123.  
 Stoeber's, for feigned amaurosis and amblyopia, 123.
- Test, von Graefe's, for feigned amaurosis and amblyopia, 125.  
 Welz's, for feigned amaurosis and amblyopia, 125.
- Tests, stereoscopic, for feigned amaurosis and amblyopia, 127.
- Tetanus due to contused wounds of the eyebrow, 7.  
 due to wounds of the cornea, 36.
- Traumatic lesions of the orbital walls, 19.  
 produced by explosions, 109.
- Traumatism of the orbital edge, 20.
- Traumatisms of the orbit, 19.
- Trismus in contusions of the eyebrows, 7.
- Vision, defects of, following hemorrhages into the vitreous humor, 90.  
 diminution of, following contusions of the eyeball, 102.  
 disturbance of, by luxation and subluxation of the crystalline lens, 78.  
 loss of, due to retinal hemorrhage, 70.
- Visual axes, direction of the, as an objective method of detecting feigned amaurosis and amblyopia, 121.
- Vitreous chamber, abscess of, 89.  
 invasion of, by large effusions, 70.  
 humor, defects of vision following hemorrhage into, 90.  
 effects of metallic foreign bodies in the, 93.  
 extravasation into, 64.  
 foreign bodies in the, 91.

- Vitreous humor, foreign bodies  
in the, diagnosis of, 91.  
prognosis of, 92.  
hemorrhage into, accom-  
panying injuries to the  
iris, 58.  
into, prognosis of, 90.  
loss of, due to penetrating  
wounds of the sclera,  
51.  
wounds of the, 89.
- Wounds in the vitreous humor, 89.
- Wounds of the conjunctiva, 15.  
complications of, 15.  
of the cornea, 33.
- Wounds of the cornea, tempo-  
rary results of, 33.  
of the eyeball, 104.  
of the eyebrows produced by  
projectiles, 8.  
of the eyelids, 10.  
by pointed instruments, 11.  
by the deflagration of gun-  
powder, 107.  
contused, 12.  
results of, 12.  
of the superciliary region, 2.  
of the supraorbital nerve, 2.  
in contusions of the eye-  
brows, 7.











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